Paper ID: 96990
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IAF SPACE EXPLORATION SYMPOSIUM (A3)
Interactive Presentations - IAF SPACE EXPLORATION SYMPOSIUM (IP)

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A REUSABLE LUNAR LANDING—LAUNCHING INFRASTRUCTURE FOR SUSTAINABLE MOON EXPLORATION

Abstract

As travel between Earth and the Moon will become more frequent in the near future, a reusable lunar lander takeoff and landing system could significantly reduce mission costs, support long-term lunar exploration, minimize impact on lunar surface facilities, and contribute to sustainable lunar development. This system employs a soft-landing approach during the descent phase. When the lander reaches a specified altitude above the lunar surface, its engines shut down, and robotic arms are activated to catch the lander, which ensures a smooth touchdown through a follow-up mechanism. The energy recovered during landing, supplemented by solar power, is then used to launch the lander via the electromagnetic catapult technology. Unlike traditional landing gear, which is attached to the lander itself, this system is fixed to the lunar surface, allowing for repeated use. The soft-landing approach minimizes impact forces on the lander that can further leverage the reusability, while shutting down the engine at a higher altitude can reduce plume effects and minimizes surface damage. Consequently, this design can reduce costs associated with lander maintenance and landing gear production, and hence lowers the expense of individual lunar missions and accelerating resource development. Furthermore, through the integration of mechanical-hydraulic systems, solar panels, and electromagnetic catapults. fuel requirements for both landing and launches can be significantly decreased. With this conserving energy, i.e. kinetic energy and potential energy, along with the solar energy collected on the moon surface, the proportion of payload dedicated to fuel storage can be considerably reduced, and this saved proportion of mass as well space can be replaced with useful payload. As a key component of the Earth-Moon transportation network, this reusable lunar takeoff and landing system could serve as essential infrastructure for sustainable lunar activities, to transform the lunar exploration from "one-time expedition" to "routine operation" and play a key role in paving the way for the establishment of a permanent lunar presence.