IAF SPACE EXPLORATION SYMPOSIUM (A3)
Interactive Presentations - IAF SPACE EXPLORATION SYMPOSIUM (IP)

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INNOVATIVE HUMAN-OPERATED PLANETARY SURFACE EXPLORATION SMART TOOL FOR ARTEMIS LUNAR MISSION

Abstract

The upcoming NASA Artemis 3 lunar mission, centered on the Moon's South Pole, prioritizes the detection of water resources. This mission task mandates the development of specialized planetary surface exploration tools for Artemis astronauts, focusing on in-situ analysis of water mass in rock samples and fundamental physical properties like mass and size. Given the unique challenges and advancements in technology since the last human-tended tools were used on the Moon over 50 years ago, there is a renewed opportunity to innovate and redefine tools for lunar exploration.

The project commenced with a meticulous project definition phase, identifying essential tool capabilities aligned with mission objectives, constraints, and heuristics. The design process incorporated learning about a combination of Apollo era tools and applying modern technologies to improve them, such as computer-aided design, 3-D printing, and controller boards like Arduino and Raspberry Pi. Concept evaluation, based on relative comparison, led to refined designs, which were further developed through detailed CAD modeling, integrating human factors considerations.

A comprehensive feasibility study, including consultation with Subject Matter Experts, culminated in the identification of a superior concept design. This design was translated into an initial prototype, subjected to ergonomic and mechanical testing using biomonitoring devices to measure muscle usage during operation. Preliminary experimentation yielded promising results, guiding recommendations for further refinement and experimentation.

Feedback from testing informed the Final Design Specifications, encompassing mechanical design, thermal components, and required instrumentation for system integration. The projected cost of the final recommended tool is approximately $10,000 USD, with a mass of around 16 kg. The tool boasts the capability to enhance sample yield and conduct in-situ analysis, with testing showing it can collect samples and store sample data in less than 13 seconds. This innovative tool promises to significantly contribute to the success of the Artemis 3 lunar mission, marking a milestone in human exploration and advancing our understanding of lunar resources.