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DESIGN OPTIMIZATION AND CONCEPTUAL INTEGRATION OF LUNAR SURFACE EXPLORATION SPACESUIT GLOVES

Abstract

With the Artemis program returning humans to the Moon, spacesuits designed for lunar surface exploration are of the utmost importance, especially considering the increased duration and frequency of surface EVAs. During the Apollo mission, glove design only allowed for 10% use of the hand, leading to significant hand fatigue in the astronauts from the repetitive gripping. Although improvements to glove designs have been made since humans went to the moon, these focused on microgravity scenarios. Even with modern EMU gloves, fatigue is still one of the main sources of injury during EVA flight. Additionally, these gloves have been optimized towards microgravity and a low earth orbit environment. This poses a problem during lunar operations as there are differences in hand usage as well as a new thermal and dust filled environment to contend with. Lunar dust is highly abrasive and has an average diameter of 70 microns, with 10% less than 10 microns. Although the EMU outer layer Ortho-fabric has a tight weave structure, it is still vulnerable to dust penetration that could damage internal material layers. Due to the differences of the lunar environment compared to microgravity, an alternate glove design is needed.

In this work, multiple trade studies focusing on various spacesuit glove design elements are performed in order to help make decisions to improve future spacesuit gloves. The trade studies include grip type and tactility, fatigue reduction, outer material selection, temperature control and insulation, and dust mitigation. Other innovative and advanced technologies will be investigated as additional points of interest as they may be better suited for lunar operations than current designs. Trade variables include dust hardiness, ease of integration with the xEMU, dexterity, mass, volume, power, and technology readiness level, as well as variables specific to each study.

From the design optimization trade studies, glove element integration is also evaluated. While different design elements may be the optimal selection within their categories, they are not necessarily compatible with each other. Integration and feasibility is important for the design of a new lunar glove. The best glove may not be a straightforward combination of the best result from each category. Additionally, the glove needs to be compatible with the current xEMU suit planned for lunar operations. Following the design optimization trade studies and the glove element integration, a final conceptual glove design best suited for lunar human spaceflight missions will be recommended.