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Author: Mr. Derek Rath
University of Southern California, United States

Mr. Madhu Thangavelu
University of Southern California, United States

# ADVANCED TACTILE OPERATIONS FROM AN AUGMENTED DUAL-LAYER SPACE GLOVE

**Abstract**

Renewing its vision for humanity on the Moon, Mars, and beyond, NASA and the international space community are preparing upcoming missions for off-world exploration. One of the key upgrades from the Apollo era program will be the physical EVA suits and equipment astronauts will employ as they explore new terrain and conduct ever more ambitious operations. Principal to these technological leaps will be a space glove, one of the most important tools on every EVA. While past gloves are notoriously lacking in dexterity and tactility, current design proposals for Artemis in 2024 show little improvement. This proposal for a two-layered augmented glove presents technological solutions already existing in modern robotics and haptics.

A next-generation space glove will include articulating robotics or grip-enhancing exoskeletons, both crucial for combatting or eliminating hand fatigue due to internal pressurization. An exoskeleton featuring grip-enhancing cable system or a micro-robotic pneumatic actuation would also allow astronauts on EVA to lock their grip's force and orientation while holding tools or operating equipment. Swappable and customizable exoskeletons also offer astronauts the possibility to equip dozens of unique accessory tools to support the variety of EVA tasks. This glove includes tactile fingertips extensions, or narrow rubberized ends, that will allow astronauts to more dexterously pick up small objects and use both standard and enhanced tools during geological exploration activity, experiments, or EVA repair and maintenance operations with greater speed and accuracy.

A two-glove system with a counter-pressure internal skinsuit layer will provide astronauts flexibility for pre-breathe times, dust and contamination mitigation between activity sites, and greater tactility. This internal glove will also feature haptic technology feeding astronauts stimuli from the outer glove, allowing them to feel and sense their surroundings and connect them more intimately with their environment. As they expand their scientific exploration of the lunar landscape and conduct geological exploration and experimentation, astronauts will receive vibrotactile stimuli from 1.5mm microfluidic wearable skin on their fingertips as they place their glove on a surface to inspect its geometry, texture and feel its other material characteristics, typical of field geologist exploration activity. Wearable skin powered by the glove will also be able to monitor and provide the accurate and timely health data and bioinformatics to a Heads Up Display, which will be important not only for monitoring the health of the crew and ensuring mission success, but also to advance space medical science.