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Author: Dr. Nina Purvis
Queen Mary University of London, United Kingdom

DESIGN OF PERFORMGLOVE FOR QUANTIFYING PERFORMANCE OF SCIENTIFIC FIELDWORK TASKS WHEN WEARING A MARS EXTRAVEHICULAR MOBILITY UNIT (MEMU) GLOVE

Abstract

Background:

It is known that wearing extravehicular mobility unit (EMU) gloves decreases performance such as grip strength, dexterity, and time to completion of tasks. They may also cause fatigue and injury such as pain, swelling, abrasions, onycholysis, and even nerve impingement. Astronauts will need to carry out scientific fieldwork tasks in partial gravity, extreme temperatures, and dusty conditions during extravehicular activities (EVAs) on the Martian surface. This contrasts with the current near pristine environment in space that current EMU gloves are designed for. Further, astronauts may undergo significant physiological deconditioning on the way to Mars. Overall, there are safety implications and the possibility of performance reduction or even no-go of EVAs. Currently, there is no publicly available Mars EMU (MEMU) glove testing protocol to choose the best of future designs from commercial companies.

Methods:

A data glove, named PerformGlove, was developed.

Design Criteria:

Provide protection for delicate sensors Minimally impact mobility, tactility, comfort Not impact on sensor performance Fit inside an EVA glove Allow some interchange of sensor size and type depending on individual anthropometry Give accessibility to wiring and for sensor placement Have pre-wiring ability Be multi-layered Be reusable Variability in anthropometrics

Sensors:

PerformGlove uses a variety of sensors and fabrics building on previous EMU glove testing efforts for previous generations of EVA glove. Measurements taken include humidity (mini humidity sensor), temperature (degrees Celsius, thermocouple sensor), nail strain (unitless mu-strain value, strain gauge sensor), fingertip blood perfusion (perfusion units, Laser Doppler Perfusion Monitor sensor), pressure (mmHg, BeBop smart fabric), range of motion (percentage maximum, bend sensors), skin conductance micro Siemens, Galvanic Skin Response sensora), and barometric pressure (psia, mini barometric pressure sensor PS-2KC, Kyowa Electronics).

Testing:

EMU gloves can be tested independently or as part of a whole suit EMU study. Various analogues are implemented such as pressurised glove boxes, ground analogue missions, parabolic flight, partial/microgravity offload systems, neutral buoyancy pools, and underwater analogues.

Mars EVA (MEVA) tasks reflecting the scientific fieldwork to be done on Mars should be selected primarily using the Generalisable Skills and Knowledge List for Exploration Missions including operating scientific instruments, tool use, collecting Martian samples, and dealing with Mars regolith contamination.

Impact and Future Directions:

Standardised MEMU glove testing protocol for mEMU glove candidates in a variety of analogues. There are various clinical applications such as assessing weakness, mobility, and dexterity as well as monitoring rehabilitation after injury or surgery.