

Integrated software systems for crew management during extravehicular activity in planetary terrain exploration

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Background.

Initial planetary explorations with the Apollo program had a veritable ground support army monitoring the safety and health of the 12 astronauts who performed lunar surface extravehicular activities (EVAs). Given the distances involved, this will not be possible on Mars. A spacesuit for Mars must be smart enough to replace that army. The next generation suits can do so using 2 software systems serving as virtual companions, LEGACI (Life support, Exploration Guidance Algorithm and Consumable Interrogator) and VIOLET (Voice Initiated Operator for Life support and Exploration Tracking). The system presented in this study integrates data inputs from a suite of sensors into the MIII suit's communications, avionics and informatics hardware for distribution to remote managers and data analysis. . **If successful, the system has application not only for Mars but for nearer term missions to the Moon, and the next generation suits used on ISS as well.**

Methods.

Field tests are conducted to assess capabilities for next generation spacesuits at Johnson Space Center (JSC) as well as the Mars and Lunar analog (Devon Island, Canada). LEGACI integrates data inputs from a suite of noninvasive biosensors in the suit and the astronaut (heart rate, suit inlet/outlet Icg temperature and flowrate, suit outlet gas and dewpoint temperature, pCO₂, suit O₂ pressure, state vector (accelerometry) and others). **In the Integrated Walkback Suit Tests held at NASA-JSC and the HMP tests at Devon Island, communication and informatics capabilities were tested (including routing by satellite from the suit at Devon Island to JSC in Houston via secure servers at VCU in Richmond, VA).**

Results.

The input from all the sensors enable LEGACI to compute multiple independent assessments of metabolic rate, from which a "best" met rate is chosen based on statistical methods. This rate can compute detailed information about the suit, crew and EVA performance using test-derived algorithms. VIOLET gives LEGACI voice activation capability, allowing the crew to query the suit, and receive feedback and alerts that will lead to corrective action. LEGACI and VIOLET can also automatically control the astronaut's cooling and consumable use rate without crew input if desired.

Discussion.

These findings suggest that non-invasive physiological and environmental sensors supported with data analysis can allow for more effective management of mission task performance during EVA. Integrated remote and local view of data metrics allow crewmember to receive real time feedback in synch with mission control in preventing performance shortcomings for EVA in exploration missions