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HUMAN SPACE ENDEAVOURS SYMPOSIUM (B3)
Enabling Technologies for Human Space Endeavours (2)

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ENABLING EVA WITH AN INNOVATIVE SPACE SUIT ARCHITECTURE

Abstract

The Morphing Upper Torso is an EVA suit architecture which incorporates robotic elements into the torso design to enable a resizable, highly mobile and easy to donn/doff spacesuit. The scye bearings, helmet ring, neck ring and waist are interconnected with the back hatch through a set of adjustable linkages, which allow repositioning and orienting of the components. These adjustable linkages allow the suit to be fitted to many sizes of crewmembers, enabling greater comfort and mobility, while minimizing custom tailoring and large stables of suit sizes. The technology also enables neck-entry suitports, a unique concept that takes advantage of the promising and emerging suitport architecture for crew transfer between EVA suits and habitats or rovers. The suitport concept is almost always envisioned with a rear-entry EVA suit, which is easy to ingress and egress but requires the crewmember to back into the suitport during egress, which could be a difficult task and requires alignment aides and tools. Neck-entry as a means of ingress/egress is used in deep-sea diving suits, however for EVA suits it is typically deemed infeasible due to the potential for difficulty of donning/doffing. The requirement of coaligning the scye bearings with the center of rotation of the crewmember's shoulders predetermines the inter-scye distance, making donning or doffing through the neck ring nearly impossible. However, the Morphing Upper Torso technology, which allows dynamic repositioning of suit components such as the scye bearings, creates the possibility for a neck-entry suit which is very easy to donn/doff but does not sacrifice mobility. Analytical and experimental models have been developed previously, which have demonstrated the feasibility of the concept, and which calculate the inverse kinematics and Jacobian of the robotics system. In this paper, an optimization of the entire system is performed, using the analytical tools developed, with the goal of optimizing over workspace and reducing the overall system power requirements. Further experimentation is described using the full scale Morphing Upper Torso along with a neck-entry donning stand, including testing various arrangements of linkages and various donning configurations. Potential actuation methods are discussed, and a prototype actuator that uses air muscle technology, is integrated into the suit. The final system is shown to require far less stowage volume than current suit architectures, minimizes suit sizing logistics and costs, improves suit fit and suit mobility, and reduces donning and doffing times.