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HUMAN SPACE ENDEAVOURS SYMPOSIUM (B3)
Astronauts: Those Who Make It Happen (5)

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ASSISTIVE ROBOTIC POWER GLOVE FOR EVA

Abstract

During extra-vehicular activities, pressurised space suits can lead to difficulties in performing hand manoeuvres, and fatigue. This is often the cause of EVAs being terminated early, or taking longer to complete. Assistive robotic gloves can be used to augment the natural motion of a human hand, meaning work can be carried out more efficiently with less stress to the astronaut. Lightweight and low profile solutions must be found in order for the glove to be easily integrated within a space suit. Pneumatic muscle actuators combined with force sensors are one such solution. These actuators are extremely light yet can output high forces using pressurised gases as the actuation drive. Their movement is omnidirectional, so when combined with a flexible exoskeleton that itself provides a degree of freedom of movement, individual fingers can be controlled during flexion and extension. This setup means all actuation hardware can be stored remotely on the user's body, allowing the least possible mass to be carried on the hand.

A prototype glove has been developed at the University of Sydney, using Festo PMAs, a fibreglass matrix exoskeleton, Flexiforce sensors and transducers to perform movements and provide feedback. The glove has been designed to increase the ease of human movements, rather than to add unnatural strength to the hand. A state space control algorithm has been developed to ensure human initiated movements are recognised, and calibration methods have been implemented to accommodate the different characteristics of each wearer's hands. For this calibration technique, it was necessary to take into account the natural tremors of the human hand which may have otherwise initiated unexpected control signals. The response of the glove between a movement command and output was found to be 0.06 seconds. The fatigue life of the glove was greater than 1000 cycles, with a 2% loss of flexion force, and the glove itself was able to produce forces comparable to those of an average healthy, unrestrained hand. The mass held by the user on the hand was 300 grams, with remote hardware, including a compressed air bottle, having a further mass of 1.6kg. These results indicate that the design is able to augment human motion in a low profile, low mass package, and could be a valuable addition to a spacesuit during an EVA.