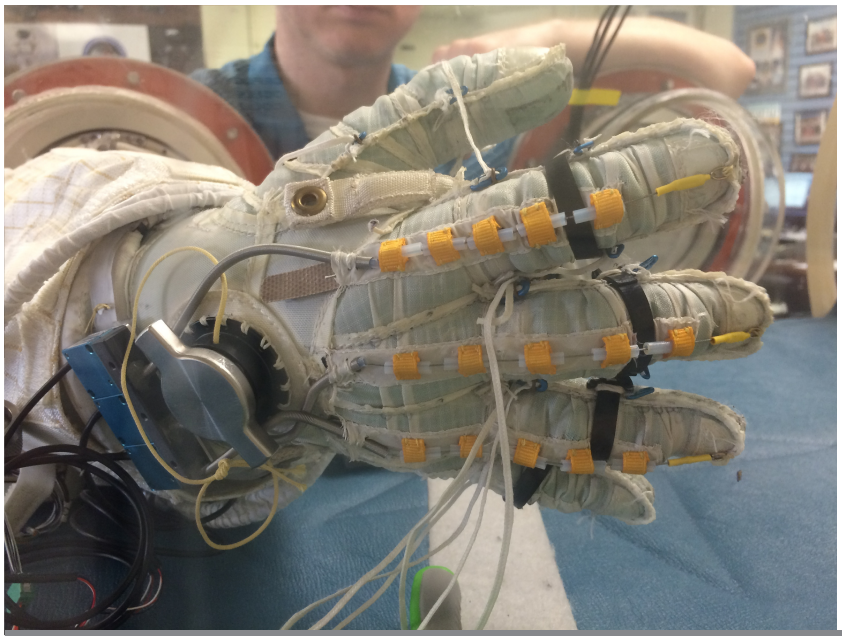

National Aeronautics and Space Administration

TECHNOLOGY SOLUTION

Robotics, Automation and Control

Space Suit RoboGlove (SSRG)

Advancements in spacesuit robotic glove may yield terrestrial benefits

Innovators at NASA Johnson Space Center (JSC) have created an enhanced second-generation, robotically assisted extravehicular activity (EVA) glove. The SSRG has been engineered to further decrease the exertion required to do complex, hand-intensive EVA tasks and reduce the risk of astronaut hand injury. Originating from its predecessors, the NASA/General Motors RoboGlove, and the later first-generation Space Suit RoboGlove, the SSRG realizes improved sensing, control, interface, and avionics capabilities. Among these improvements is the implementation of a “power steering mode”, which allows the user to position his/her fingers in an arbitrarily chosen position and receive assistance in holding that position. The SSRG retains the ability to operate like a conventional space suit glove while the actuators are unpowered. The design intent for the SSRG is to enhance a user’s ability to perform human scale work, with considerations for speed, power, durability, dexterity, and ease of operation.

BENEFITS

- “Power-steering mode” allows user to receive assistance holding arbitrarily chosen position
- Decreases exertion required to do complex, hand-intensive tasks
- Reduces risk of hand injury
- New actuator realizes greater force output, increased efficiency, higher thermal mass, improved reliability, and ease of maintenance
- Improved sensing, control, interface, and avionics capabilities over first-generation glove
- Capable of providing 9 assistive modes
- Back drivability of actuators ensures user unpowered mobility

THE TECHNOLOGY

NASA is currently developing the next generation space suit for future missions, including the optimization of space suit gloves. When non-assisted space suit gloves are coupled to a pressurized suit and operated in a vacuum, they tend to limit the range of motion of an astronaut's hand to as little as 20% of normal range. Many of NASA's future missions will be in challenging environments where an astronaut's hand dexterity will be critical for the success of NASA missions. Innovators at JSC have improved the performance on the second-generation, robotically assisted SSRG, to reduce exertion and improve the hand strength and dexterity of an astronaut in situ.

The SSRG's system detects user finger movements using string potentiometers and contact with objects using force-sensitive resistors (FSRs). FSRs are imbedded in the distal and medial phalanges, palmar side of the glove. To move a finger, an actuator pulls a tendon through a Bowden Cable system which transfers mechanical pulling force of an inner cable relative to a hollow outer cable, like the brakes on a bicycle, as seen in the Figure below. An improved controller commands the new, more powerful linear actuator to drive tendon operation while minding custom controller parameters inputted through a digital editor tool.

The Space Suit RoboGlove is at TRL 6 (system/subsystem model or prototype demonstrated in a relevant environment) and it is now available for licensing. Please note that NASA does not manufacture products itself for commercial sale.

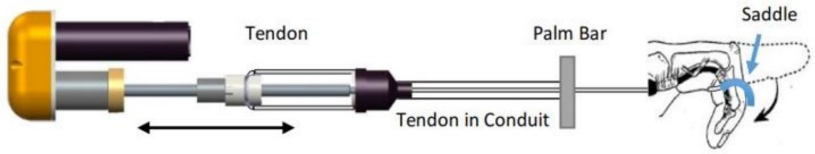

Figure 3. Single Actuator Mechanical System

APPLICATIONS

The technology has several potential applications:

- Manufacturing: operation of hand tools and hand-gripping manual labor for extended periods of time
- Healthcare: development of rehabilitation aids, and assistance of patients with impaired hand muscle strength

PUBLICATIONS

Patent No: 10,888,487; 11,019,862; 11690775

Patent Pending

technology.nasa.gov

NASA's Technology Transfer Program pursues the widest possible applications of agency technology to benefit US citizens. Through partnerships and licensing agreements with industry, the program ensures that NASA's investments in pioneering research find secondary uses that benefit the economy, create jobs, and improve quality of life.

MSC-26236-1, MSC-26273-1, MSC-26236-2, MSC-26273-2, MSC-TOPS-80

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NP-2019-10-2772-HQ