The Guided Robotically Assisted Space glove aPparatus (GRASP)

Khang Duong

Virginia Aerospace Science and Technology Scholars

Abstract

Spacesuit gloves are interesting because when designing them, one must consider the durability in space and the flexibility required. Because the glove is inflated, it is hard to move the glove fingers (Gernhardt et al., 2009). The Guided Robotically Assisted Space glove aPparatus (GRASP) intends to fix this problem. GRASP uses motors pulling synthetic tendons similar to those on the Robonaut 2 to close the hand robotically (NASA, n.d.c). It is attached to the spacesuit glove itself and has a feature where the user can lock the hand in place. This function is for monotonous tasks that require the use of one tool. The user does not have to further strain his/her hand holding a tool. This innovation controls automatically through sensors located on the fingers. However, the locking function can be activated via switches on the astronaut’s control module. Astronauts in training will practice with GRASP in virtual reality and then move on to the Neutral Buoyancy Laboratory (Virginia Aerospace Science and Technology Scholars, n.d.).

The Guided Robotically Assisted Space glove aPparatus (GRASP)

Scientists at NASA have been improving space suit gloves for a while. However, it is not perfect. Hand injuries are the most common form of EVA injury (Gernhardt et al., 2009). To counter this, astronaut gloves should be fitted with robotic enhancements that decrease strain on the hands and wrists. The Guided Robotically Assisted Space glove aPparatus, or GRASP would have automatic control through sensors located on the fingers. It runs on five space-grade motors pulling synthetic tendons, similar to those of Robonaut 2. Astronauts-in-training would practice this innovation during their EVA simulations.

The robotic enhancements’ purpose is to decrease strain on the human hand, limiting the injuries. EVAs require many hand and arm movements. These movements are especially hard because of the suits’ inflatable nature. It requires a significant amount of force to move an inflated spacesuit glove (NASA, n.d.a). This innovation would assist the user in moving the inflated spacesuit glove to prevent hand fatigue. With sensors on the fingers and servo motors pulling manufactured tendons, GRASP would increase grip strength and aid in the grasping for rails, tools, or levers. Additionally, the gloves would be able to lock in place, allowing the user to perform monotonous tasks without continuously straining his/her hands. GRASP would help in an EVA by decreasing fatigue. Fatigue is a “constant concern” during EVAs because of some of the most important tasks of every EVA, such as “ingressing the airlock, shutting the hatch, and reconnecting the suit umbilical line,” require significant effort (NASA, n.d.a). If an astronaut were too fatigued, he/she would not be able to perform those tasks. In addition, hand injuries are the most common injury for EVA astronauts. This is due to the “increased force needed to move pressurized, stiff gloves or repetitive motion for task completion” (Gernhardt et al., 2009). GRASP would solve this issue by helping the user close their glove, and locking it with a tool in hand if needed.

GRASP will be automatically controlled by sensors located on the spacesuit fingertips. Based on the pressure detected on the sensors, the motors will activate and close to the desired strength. Also, two switches corresponding with each glove on the control module will toggle the lock in place feature.

Astronauts will use GRASP during their EVAs when grasping tools, railings, etc. The innovation is automatic, except for toggling the glove lock. When holding a tool that will be used for a long duration of time, astronauts have the ability to lock the hand holding the tool. This is turned on with switches on the control module. The control module is a panel on the chest of the spacesuit. The user can control life support systems on the spacesuit with this panel. GRASP will add two switches to this panel. To switch the lock mode on, astronauts will use their wrist mirror to look at the control module and flip the correct switch (NASA, n.d.b).

GRASP is controlled by five space-grade servo motors located at the wrist. When the sensors on the fingertips recognize that pressure has been applied, the motors pull in five artificial tendons (one for each finger) located on the palm-side of the fingers. When a lock has been applied, the motors will tighten up, not allowing the fingers on that hand to move. A microcontroller is the brains of GRASP. It will work in conjunction with the motors and sensors to close the glove (NASA, n.d.c).

Because GRASP is a suit improvement, the astronaut will train with it whenever they train with the suits. First, astronauts will start just wearing the gloves to get a feel for the increased grip strength. Then, they will move on to virtual reality, practicing with GRASP with the views that they will experience during and EVA. Finally, astronauts in training will practice using GRASP in the Neutral Buoyancy Laboratory during their EVA training. GRASP will have to be redesigned to work underwater. During each of the practices at the Neutral Buoyancy Laboratory, GRASP will be active, to ensure that they get plenty of practice with it (Virginia Aerospace Science and Technology Scholars, n.d.).

In conclusion, the Guided Robotically Assisted Space glove aPparatus would help by decreasing the strain on astronauts’ hands. It is an automatic device that is manually controlled via switches on the astronaut’s control panel. GRASP contains sensors, motors, and a microcontroller. These three work in tandem to close the glove when needed. Astronauts in training will practice with it through virtual reality and in the Neutral Buoyancy Laboratory. As technology improves, many aspects of life become delegated to and improved by robotics. Spacesuits are just the same.

References

Gernhardt, M. L., Jones, J. A., Scheuring, R. A., Abercromby, A. F., Tuxhorn, J. A., & Norcross, J. R. (2009, January). *Risk of Compromised EVA Performance and Crew Health Due to Inadequate EVA Suit Systems* . Retrieved January 11, 2020, from https://humanresearchroadmap.nasa.gov/evidence/reports/eva%20suit.pdf

NASA. (n.d.). *Extravehicular Activity Operations and Advancements*. Retrieved January 11, 2020, from https://www.nasa.gov/centers/johnson/pdf/584725main\_Wings-ch3d-pgs110-129.pdf

NASA. (n.d.). Learn About Spacesuits. Retrieved January 11, 2020, from https://www.nasa.gov/audience/foreducators/spacesuits/home/clickable\_suit\_nf.html

NASA. (n.d.). *The Robonaut 2 Hand – Designed To Do Work With Tools*. Retrieved from https://ntrs.nasa.gov/archive/nasa/casi.ntrs.nasa.gov/20110023122.pdf

Virginia Aerospace Science and Technology Scholars. (n.d.). Simulations. Retrieved January 11, 2020, from https://vsgc.spacegrant.org/course/mod/book/view.php?id=7066&chapterid