External Robotic Arms Design and Purpose

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Abstract

The International Space Station (ISS) requires occasional repairs outside, that necessitates the use of space suits that are hard to control and maneuver around in space due to all the protective layers and insulation needed to survive in space. Because the spacesuits are not agile, it makes it difficult to make repairs to the space station. The External Robotic Arm (ERA), will be an attachment to a slightly modified version of the NASA EMU space suit. ERA is an addition of four robotic external “arms” that can be enhanced with modules, and can be maneuvered by astronauts inside the ISS and at NASA’s headquarters on earth. The ERA has different modules that can be attached to the ends of the robotic arms such as cameras, caulking nozzles, flashlights, clamps, displays, etc. Different companies will be able to design their own modules to be attached to the ERA. The ERA gives the astronauts the ability to accomplish more tasks and repairs in a shorter amount of time, with better precision and accuracy when repairing the station during an Extra Vehicular Activity (EVA).

External Robotic Arms Design and Purpose

The purpose of the External Robotic Arms (ERA) is designed to help astronauts repair the International Space Station quicker and safer. The ERA gives the astronauts more diverse tools to help them repair damages with better accuracy. ERA is designed for use with many different swappable modules that are able to be controlled remotely by another person either on the ISS or even in NASA’s mission control center on earth. The different modules can give the ERA limitless functionality to achieve and complete many different tasks. The astronauts can request certain tools from the engineers at NASA and NASA can send the astronauts blueprints of modules that can be 3D printed in the space station’s 3D printer (Loff, 2015).

The External Robotic Arms (ERA) can be voice-controlled for basic functions such as directions, and can be remotely controlled for more precise tasks. Simple voice commands will enable the astronaut to turn on a module and bring it closer or further. Other astronauts inside the space station can have the ability to manually control each individual arm, using bluetooth technology to communicate to ERA in order to perform sensitive procedures that require more dexterity and finer motor skills.

The astronauts will be able to swap different modules on each of the arms, depending on their needs and missions such as cameras, caulk spray nozzles, thermal sensors, displays to show the steps for repair, and any tools that could enhance the process of repairing. ERA has four mechanical arms that can each be controlled separately. The astronauts will be able to conduct more scientific research by attaching different measuring equipment modules. The modules can be made and designed by other companies due to the ERA being an Open Source Hardware innovation (Open Source Hardware Association, 2019).

In order for the External Robotic Arm to be able to attach to the spacesuit, there will need to be 4 handles added to the backpack of the spacesuit that match with the base of the ERA. The handles of the backpack will be placed 15 centimeters from the top of the midpoint of the backpack and along the mid points of the sides of the backpack. The ERA will have clamps on the hollow cylinder that will attach to the handles and secure them to the spacesuit. (Dunbar, 2009). The hollow cylinder is where the computer, battery, and frame are located. The frame is “a coordinate system used to determine a position and orientation of an object in space (Productivity Incorporation). The mount for the mechanical arms will extrude out of a hollow cylinder that has a diameter of 58.4 centimeter and a height of 22.0 centimeters. The four mechanical arms will be attached at 45, 135, 225, and 315 degrees along the circumference of the hollow cylinder in between the two bases of the cylinder. Each arm is made of segments of different lengths connected by mechanical joints. A rotation disk located on each joint will enable rotation of the segment. A typical arm would start at a joint at the connection to the hollow cylinder. The first segment would be twenty centimeters long. The next two segments would be fifty centimeters long. The last segment would be the module, which would be attached via the Module Insertion Access Point to the last joint to the fourth joint. This fourth and last joint, will have a rotation disk.

In order to use the External Robotic Arm (ERA), astronauts will need to learn how to work together and communicate directions to each other. The Astronauts will also learn how the modules fit onto the arms, how the different modules function, and how to take them apart for storage. After the team of astronauts learn how to communicate with each other effectively and use the different modules, they will then have to learn how to use it in simulated zero gravity at the Neutral Buoyancy Lab in Texas, the only lab in the United States where they have a pool large enough to make a replica of the International Space Station (Terdiman, 2014). They will be given the opportunity to maneuver the ERA into different positions to fix broken parts of the space station. In training, the astronauts will use a heavier modified version of the ERA with added weights that enable it to function similarly in water as it does in the microgravity near the space station. (Dunbar, 2015). In addition to the astronauts, the engineers will need to be trained on the specifications of ERA in order to design new parts and modules.

The space suits used by astronauts on EVAs are not very agile for making repairs to the International Space Station, and they rely on the pair of eyes and hands of the astronaut. The ERA will provide additional “eyes,” via cameras or mirrors, monitors, magnifying attachments and additional “hands” to enhance the activities of the astronaut making the repairs. The External Robotic Arm is an attachment to the current space suit that allows the astronauts to have four external mechanical arms that can be controlled independently by astronauts in the space station with different modules to help the astronauts complete their tasks when on a spacewalk. It has better mobility and allows for more accuracy making repairs in space. It allows the intervention of engineers on earth to devise solutions for unforeseen repairs and with the use of a 3D printed module can speed up repairs. It shortens the time the astronaut is in space and therefore decreases the potential for danger when astronauts are too exhausted from moving around in the cumbersome suits.

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