NASA**facts**

Space Technology
Game Changing Development
Robonaut 2

Overview

Robonaut 2 (R2) has been aboard the International Space Station since launching aboard space shuttle Discovery on the STS-133 mission in February 2011. It is the first humanoid robot in space, and although R2's primary job for now is demonstrating to engineers how dexterous robots behave in space, the hope is that future dexterous robotic platforms could serve as caretakers for future exploration spacecraft and habitats.

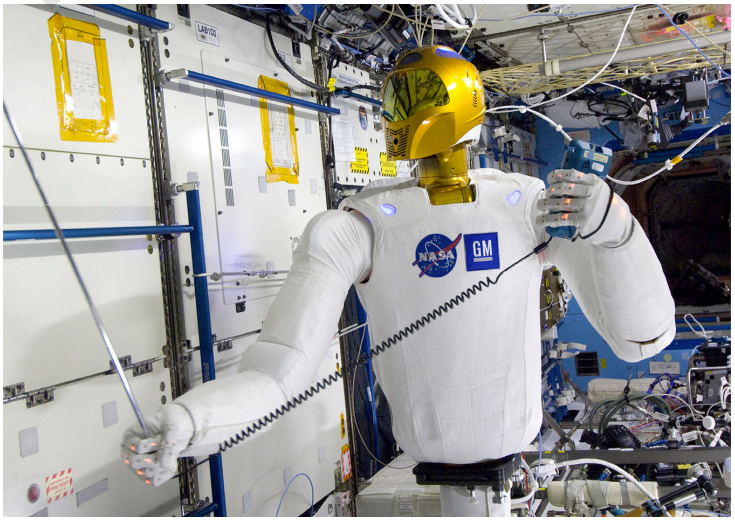
R2 powered up for the first time in August of 2011. Since then, robotics engineers have tested R2 inside the Destiny Laboratory, completing tasks ranging from taking air measurements to handrail cleaning, simple but necessary tasks that require a great deal of crew time. R2 also has a task board on which to practice flipping switches and pushing buttons. It has been controlled by station astronauts on multiple occasions through the use of virtual reality gear.

History

Work on the first Robonaut began in 1997. The goal was to build a humanoid robot that could assist astronauts with tasks when another pair of hands would be helpful or perform jobs either too dangerous or too time-consuming for crew members.The result was R1, a human-like prototype of a robot that could perform maintenance tasks or be mounted on a set of wheels to explore distant destinations.

Through 2006, R1 performed in numerous experiments in a variety of laboratory and field test environments, proving that the concept of a robotic assistant was valid. The same year, General Motors (GM) expressed an interest in hearing about the project. GM had been developing its own dexterous robots and, after seeing what NASA had already accomplished, proposed teaming up. A Space Act Agreement was signed in 2007 to allow GM and NASA to pool resources and work together on the next-generation Robonaut.

In February 2010, R2 was unveiled—a faster, more dexterous, more technologically advanced humanoid robot than had ever been seen before. Its potential was quickly recognized, and it flew on space shuttle Discovery's final mission to the space station. There it is making history as the first humanoid robot in space, and through providing engineers a first look at how a humanoid robot actually performs in the absence of gravity.



R2 takes airflow measurements aboard the ISS.

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R2 was upgraded in 2014 with robotic legs, more powerful computing capabilities, and a vastly improved software control and safety system. These improvements will allow R2 to move around the International Space Station (ISS), allowing engineers to develop technologies needed for robotic maintenance and servicing of space station structures and systems. Some tasks envisioned for R2 include inspection, logistics management, and light maintenance. These are all essential tasks currently completed by human crew.

Current

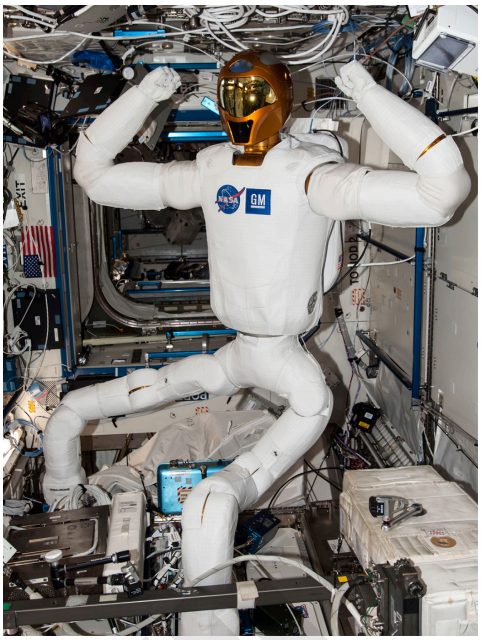
The R2 units on the ground are active in robotics technology advancement efforts that will be needed for caretaking of crewed and dormant spacecraft. These technologies include dexterous manipulation of tools, cognitive computing, machine vision processing, autonomous planning and commanding, and human-robot interactions. The safety and control system developed for the on-orbit R2 provide an accessible interface to university and industrial partners whose co-development of these important technologies is essential for enabling future exploration missions.

Future

The ISS is only the first of R2's possible missions. Conditions aboard the space station provide an ideal proving ground for robots to work shoulder to shoulder with people in microgravity. This will help NASA understand robotic capabilities for future deep space missions.

As R2 technology matures, similar robots could be sent deeper into space to test the system in more extreme thermal and radiation conditions. Someday, a future Robonaut could service communications, weather, and reconnaissance satellites, which have direct benefits on Earth.

The next step for robotic capabilities such as R2 would be to enable dormant periods of crewed spacecraft and habitats by providing robotic caretaking abilities. Humans currently provide the necessary maintenance, logistics support, and commanding needed to successfully operate the ISS. In future exploration missions, there will be periods where spacecraft or habitats are uncrewed. During those periods, most systems will need to exist in a reduced capability state in order to maintain the integrity of the spacecraft. A dexterous mobile robot such as R2 would be able to provide the limited "hands-on" support that will be needed to ensure the spacecraft remains healthy.



R2 with robotic legs inside the ISS.

This evolution of capabilities for both robotic and human exploration will make a Mars surface mission possible. This human-robotic partnership will allow Mars surface missions to be conducted safely by a smaller crew—without sacrificing mission plans and results.

There is a logical progression for the next generation of space exploration. The first look at a new destination is through a telescope, then through the eyes of robotic precursors and caretakers, such as R2, followed by arrival of human explorers. Humans and robots exploring the solar system together will provide greater results than either could achieve alone, enabling an exciting future of exploration.

The Game Changing Development (GCD) Program investigates ideas and approaches that could solve significant technological problems and revolutionize future space endeavors. GCD projects develop technologies through component and subsystem testing on Earth to prepare them for future use in space. GCD is part of NASA's Space Technology Mission Directorate.

For more information about GCD, please visit http://gameon.nasa.gov/

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FS-2017-03-00226-NSSC