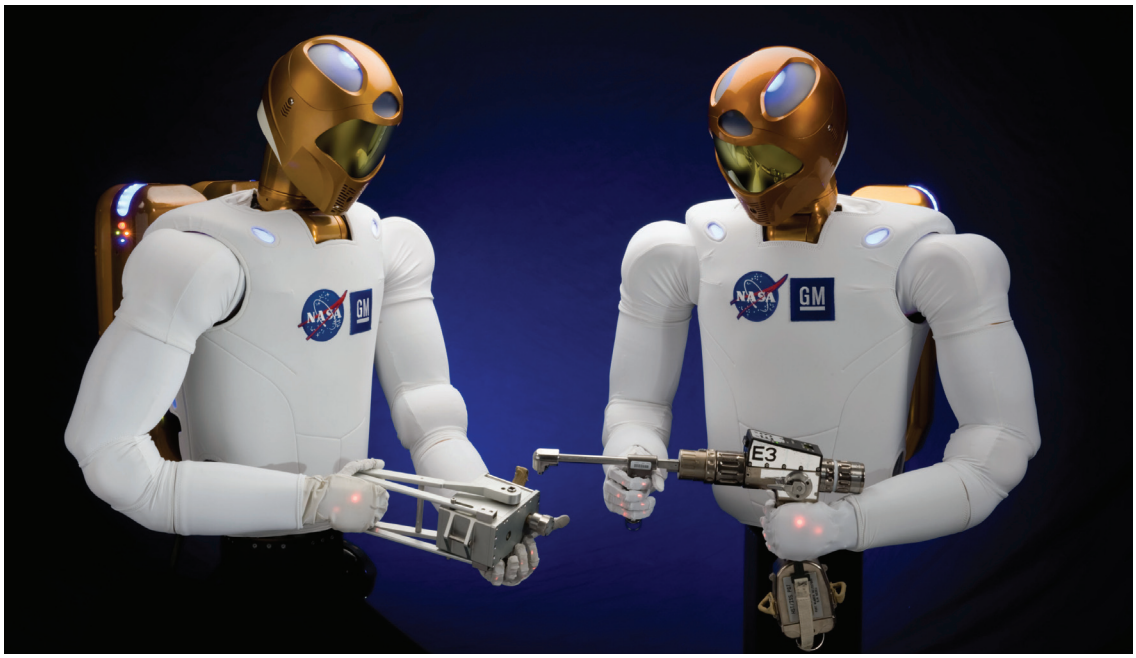
NASAfacts

Robonaut 2: The Next Generation



Robots and Humans Exploring Together

For thousands of years, humans have moved into new territories, surveying and exploring, pushing the limits of discovery. Today, we look to explore deep space, a hostile and unforgiving environment where humans and robots must work together in order to succeed.

To make these missions possible, NASA is developing advanced robotic capabilities needed to survey deep space and planetary surfaces and to map the way for future human exploration. The robots are also designed to safely work with humans for joint human-robotic missions. Robonaut 2, or R2 for short, is one of these advanced robotic capabilities being developed. It is the next generation dexterous robot, developed through a Space Act Agreement between NASA and General Motors.

Background:

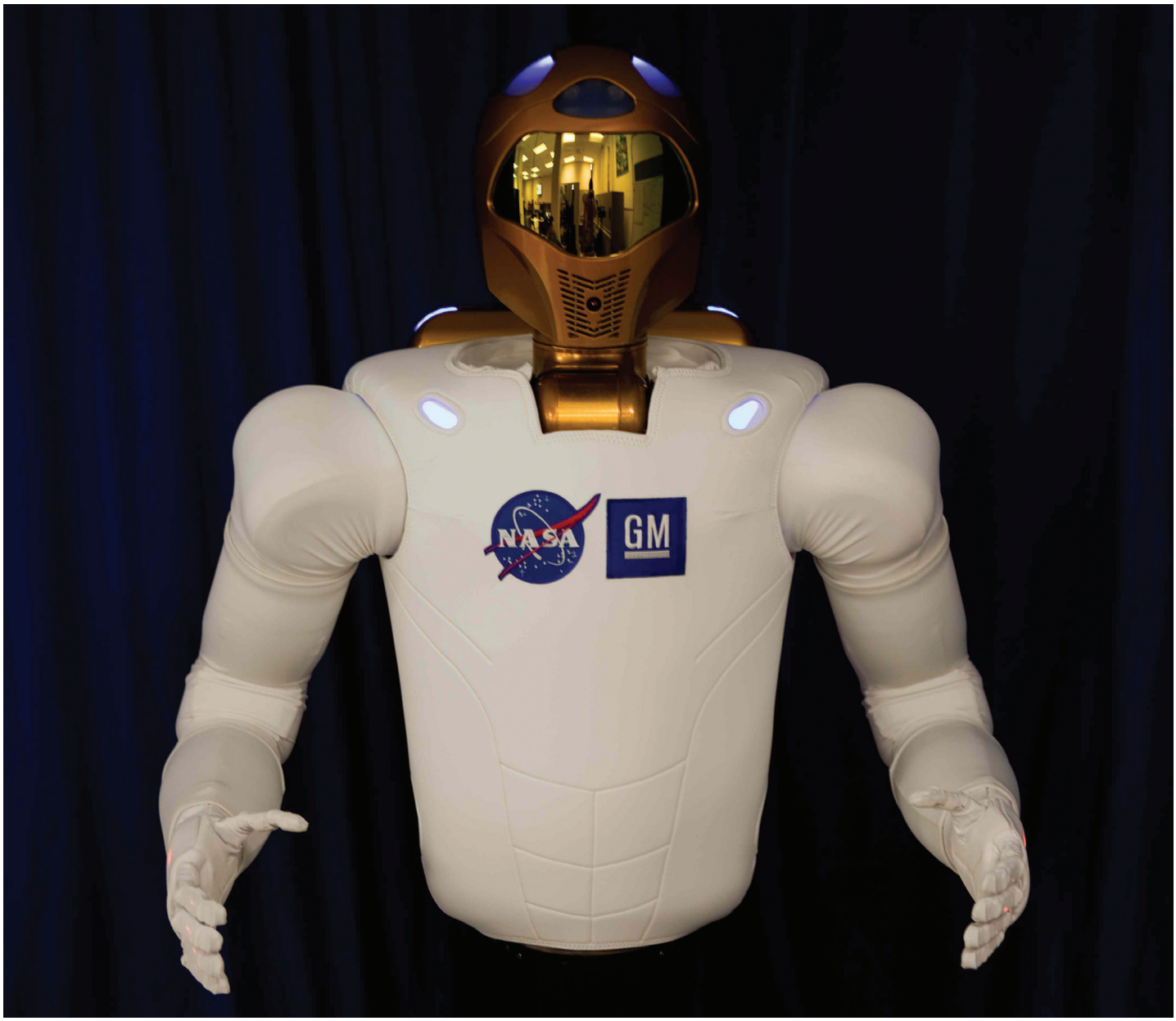
The idea of using dexterous, human-like robots capable of using their hands to do intricate work is not new to the aerospace industry. The original Robonaut, a humanoid robot designed for space travel, was built 10 years ago at NASA's Johnson Space Center in a collaborative effort with the Defense Advanced Research Project Agency. During the past decade, NASA gained significant expertise in building robotic technologies for space applications. These capabilities will help NASA launch a bold new era of space exploration.

The Robonaut project seeks to develop and demonstrate a robotic system that can function as an extravehicular activity astronaut equivalent, even performing tasks not specifically designed for robots. Robonaut jumps generations ahead by eliminating the robotic scars, such as special robotic grapples and targets, and specialized tools of traditional on-orbit robotics. However, it still keeps the human operator in the control loop through its tele-presence control system.

Robonaut 2

In the current iteration of R2, the team focused on improving its speed, dexterity and workspace. Robonaut seeks to improve mission efficiency. The dexterity of R2 allows it to use the same tools that astronauts currently use and remove the need for specialized tools just for robots.

One advantage is that R2 can take over simple, repetitive, or tasks especially dangerous to astronauts on places such as the International Space Station. Because R2 capabilities are approaching human dexterity levels, tasks such as changing out an air filter can be performed without modifications to the existing design.



Robonaut 2 Specifications:

Materials: Primarily aluminum with steel, and non-metallics

Weight: 330 pounds

Height: 3 feet, 4 inches (from waist to head)

Shoulder Width: 2 feet, 7 inches

Sensors: 350+, total

Processors: 38 power PC processors

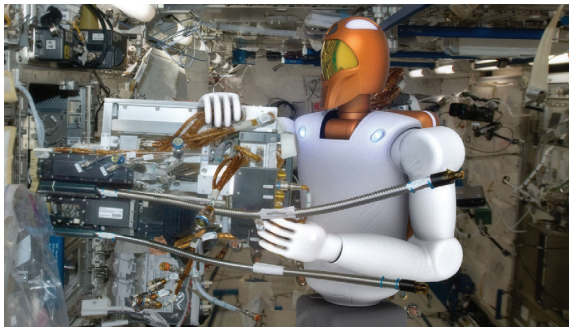
Degrees of freedom: 42, total

Speed: Up to 7 feet per second

The Future

R2's first assignment will be aboard the International Space Station. The conditions aboard the space station provide an ideal test bed for robots to work in close proximity to humans, while also working in a zero gravity environment. Once demonstrated inside the space station, software upgrades and mobility aids will be incorporated, allowing R2 to work outside in the vacuum of space. This will help NASA prepare for robotic capabilities for future deep space missions.

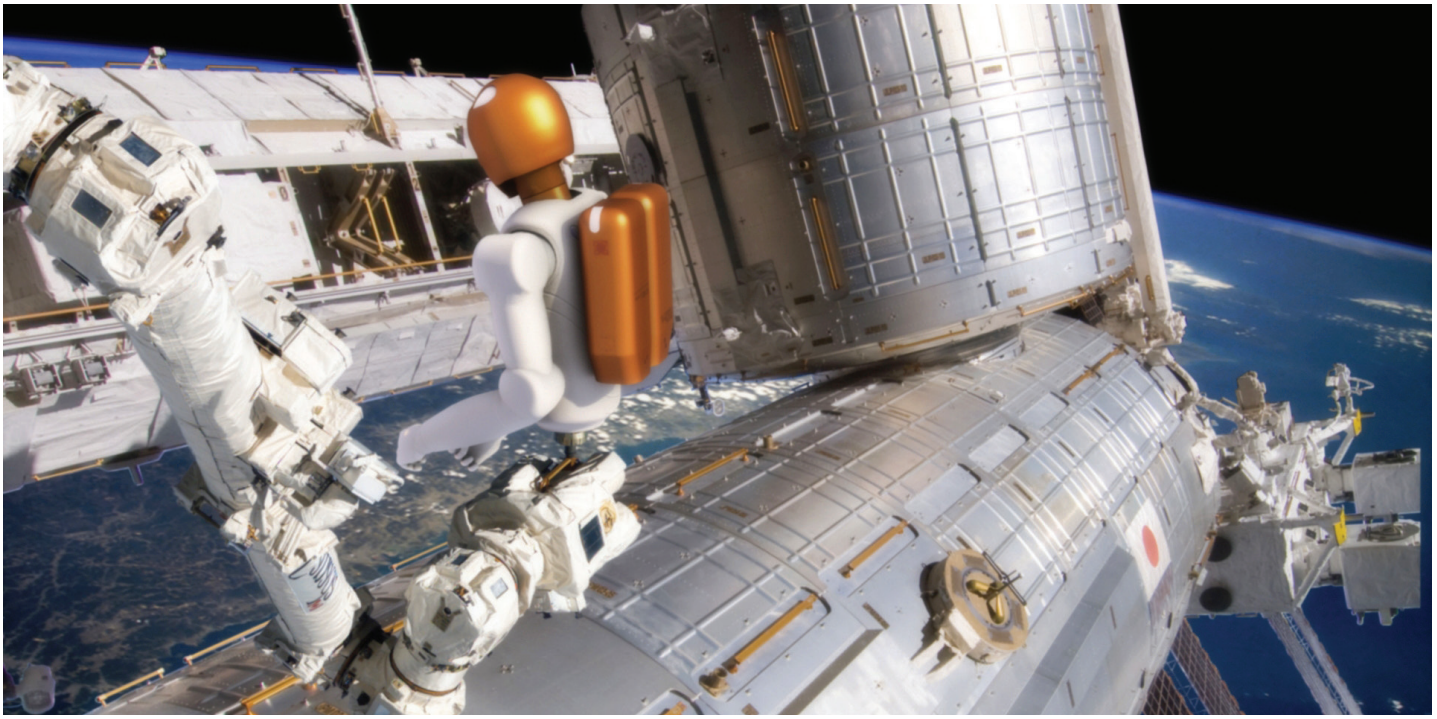
As R2 technology matures, it will move on to complete tasks deeper in space. This will test technologies for more extreme thermal and radiation conditions, as well address new challenges posed by microgravity. This will also allow R2 to service communications, weather and reconnaissance satellites, which have direct benefits on Earth.



The next step for robotic capabilities such as R2 will be to explore near-Earth objects, including asteroids and comets, with the eventual destination being Mars and Mars' moons. The robot will serve as a scout, providing advanced maps, sampling data, answers about basic surface compositions and advanced infrastructure support in preparation for human arrival. Humans will then be able to explore the near-Earth object, much more prepared than they would be without the robotic scouting mission.

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. Our first look at a new destination is through a telescope, then through the eyes of a robotic precursor 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 new discoveries!



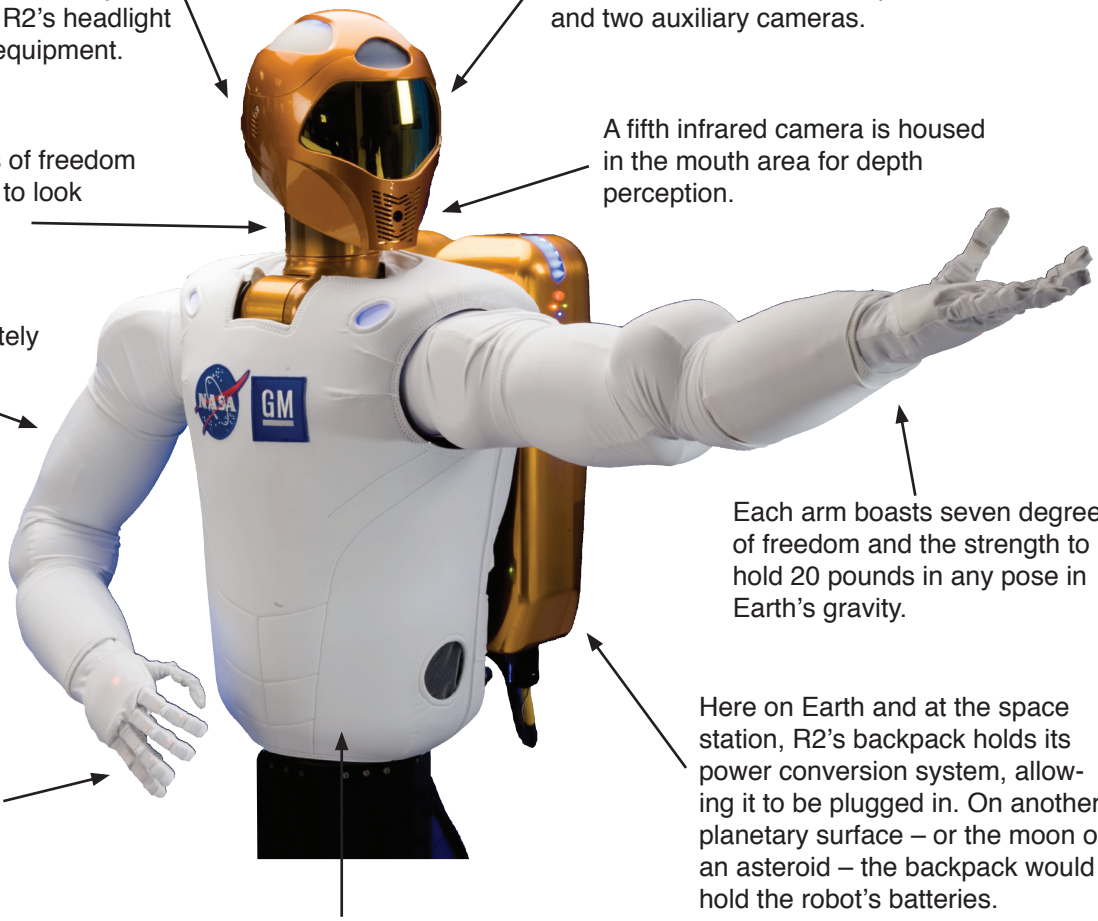
What Robonauts Are Made Of

A robot designed to work with humans and use human tools begins to look humanlike by default. However, R2's headlight houses its vision equipment.

Behind R2's visor are four visible cameras – two to provide stereo vision for the robot and its operators, and two auxiliary cameras.

R2 has three degrees of freedom in its neck, allowing it to look left, right, up or down.

A fifth infrared camera is housed in the mouth area for depth perception.



Each arm is approximately 2 feet, 8 inches long, giving the R2 a total wingspan of 8 feet.

Each arm boasts seven degrees of freedom and the strength to hold 20 pounds in any pose in Earth's gravity.

R2's hands have 12 degrees of freedom -- four in the thumb, three each in the index and middle fingers and one each in the ring and pinky fingers. Each finger has a grasping force of 5 pounds.

Here on Earth and at the space station, R2's backpack holds its power conversion system, allowing it to be plugged in. On another planetary surface – or the moon or an asteroid – the backpack would hold the robot's batteries.

R2 thinks with its stomach – literally. With its head full of cameras, the only place with enough room for a brain is the robot's torso.

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