Lower limbs for Robonaut 2 are aboard the International Space Station

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NASA's Robonaut 2 with its newly developed climbing legs, designed to give the robot mobility in zero gravity. With legs, R2 will be able to assist astronauts with both hands while keeping at least one leg anchored to the station structure at all times. Credit: NASA

(Phys.org) —Getting your "space legs" in Earth orbit has taken on new

meaning for NASA's pioneering Robonaut program.

Thanks to a successful launch of the SpaceX-3 flight of the Falcon 9/Dragon capsule on Friday, April 18, the lower limbs for Robonaut 2 (R2) are aboard the International Space Station (ISS). Safely tucked inside the Dragon resupply vehicle, R2's legs are to be attached by a station crew member to Robonaut's torso already on the orbiting outpost.

R2's upper body arrived on the space station back in February 2011 during the last flight of the space shuttle Discovery. That event signaled the first human-like robot to arrive in space to become a permanent resident of the laboratory.

Jointly developed by NASA's Human Exploration and Operations and Space Technology mission directorates in cooperation with with General Motors, R2 showcases how a robotic assistant can work alongside humans, whether tasks are done in space or on Earth in a manufacturing facility.

"NASA has explored with robots for more than a decade, from the stalwart rovers on Mars to R2 on the station," observes Michael Gazarik, the associate administrator for NASA's Space Technology Mission Directorate (STMD). "Our investment in robotic technology development is helping us to bolster productivity by applying robotics technology and devices to fortify and enhance individual human capabilities, performance and safety in space."

Some assembly required

The R2 now consists of a head and a torso with two arms and two hands. With the addition of the newly developed climbing legs, the robot can augment its chief role: to help astronauts by taking over some of their duties on the space station.

But before R2 is up and running with its new limbs, there's some assembly required.

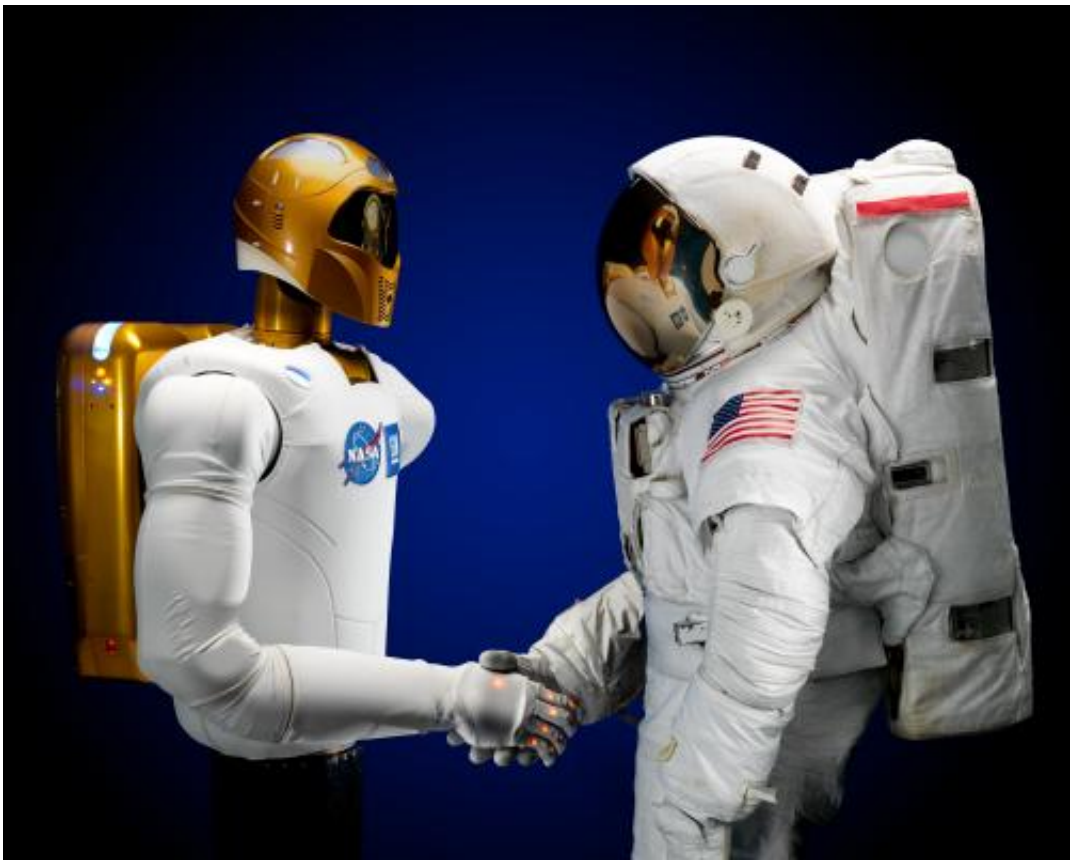
"We've got a number of upgrades we're doing," says Ron Diftler, Robonaut Project Manager within the Robotic Systems Technology Branch at the NASA Johnson Space Center. "In sending up the legs, we also have to change things inside R2's body."

That includes new computers, new wiring, mechanical assembly, and interfacing the legs to R2's main processor. "We have it all mapped out," Diftler explains.

In practice runs at NASA Johnson Space Center, reconfiguring R2 to adopt its legs has taken about 14 hours, spread out over several steps in time. "We see about 20 hours of ISS crew time to do the task, following detailed procedures and done over at least a month," Diftler adds.

Going mobile

For the Robonaut team, outfitting the torso with legs is a major milestone.



Robonaut 2 (R2) is a dexterous, humanoid astronaut helper. R2's torso, head and arms are now aboard the International Space Station. Upgrades, such as the robot's new high-tech legs, will extend its use both inside and ultimately outside the orbiting complex. Credit: NASA

"We'll go from being the first humanoid robot in space to being the first mobile humanoid robot in space," Diftler proudly points out. "Being mobile significantly adds to our capability."

Right now, the R2's torso, head and arms are secured to a stationary base, so crew members take tasks to the robot.

But getting a literal leg-up on mobility extends the jobs R2 can perform.

"We call them the 3 D's…the dull, dangerous, and dirty," Diftler notes, those functions that free-up astronaut time to safely complete more vital work. "That's what robots are for. The astronauts are highly capable individuals that should not have to do all the tasks that require a human-like hand. The whole idea is that we want to reduce the burden on the crew in all situations," he explains.

International Space Station crewman, Dan Burbank, shakes hands with NASA's Robonaut 2. Credit: NASA

Inside job

Think of it as one small step for robotkind.

That is, R2's legs will allow it to slowly saunter around the space station. Making use of toe-like fixtures—called "end effectors" that take the place of feet—R2 can use sockets and handrails to move about. With legs, the robot can lend a hand, or two, to the crew while secured to the station by at least one leg.

"The legs are very flexible. They can orient themselves in non-humanoid ways," Diftler explains, with each leg having many joints to provide that suppleness. "It's not the kind of symmetry that you have in a human," he says, but we were not trying to run a beauty contest."

Having R2 climb about inside the space station is an early test run of, eventually, having the automaton work outside the complex.

"Once we are able to go outside the station with an upgraded and more robust R2, then we can start going after some of the more mundane, perhaps dangerous jobs, and help the crew there too," Diftler says.

Stepping stones

Advancing R2's "to do" list both inside and outside the International Space Station are seen as stepping-stones.

"My goal and the goal of my division," Diftler says, "is that wherever humans go, be it an asteroid, back to the Moon, or on to Mars, we want to send a Robonaut. We want to do so either before humans go to set things up, to go with them to help as they do their exploration…or to maintain a habitat when humans aren't there."

Using the space lab as a test bed for putting muscle behind maturing the NASA R2 system paints a pathway forward, beyond low Earth orbit.

Diftler says R2's work at the ISS is more of a technology demonstration

than experiment. The team's confidence level in robot building and testing is high.

"We're working out all of the issues so that future Robonauts can become ever more reliable," Diftler concludes. "This is an absolutely exciting time for NASA and for our robotic work."

Provided by NASA