



Robotics, Automation and Control

## Robonaut 2 Technologies

For use in logistics and distribution, medical and industrial robotics, and hazardous, toxic, or remote

Researchers at NASA's Johnson Space Center (JSC), in collaboration with General Motors and Oceaneering, have designed a state-of-the-art, highly dexterous, humanoid robot: Robonaut 2 (R2). R2 is made up of multiple component technologies and systems -- vision systems, image recognition systems, sensor integrations, tendon hands, control algorithms, and much more. R2's nearly 50 patented and patent-pending technologies have the potential to be game-changers in multiple industries, including logistics and distribution, medical and industrial robotics, as well as hazardous, toxic, or remote environments.

### BENEFITS

- Dexterous hands
- Touch sensitive
- Able to navigate around obstacles
- Environmentally aware
- Mobile
- Capable of task flexibility
- Able to work in proximity to co-worker

technology solution



# NASA Technology Transfer Program

Bringing NASA Technology Down to Earth

## THE TECHNOLOGY

While robotic technologies are already being used in several industries like logistics and distribution, R2 allows for much more complex and delicate operations that require a more sophisticated level of interaction. In terms of handling inventory, R2's dexterity would allow it to handle a multitude of items, including delicate ones. In addition, it can perform in close proximity to humans, allowing for the use of robotics in areas where it's not currently safe or practical. R2 is equipped to navigate obstacles, fixed or moving and has the capability of handling frequent, random, and unexpected movement of people, products, or equipment as well as items that vary in shape, weight, and fragility.

The robot encompasses four elemental systems.

**Hands:** R2's unprecedented dexterity in its hands allows it to use many of the same tools that astronauts and industry workers currently use, significantly reducing the need for specialized tools to perform multiple tasks.

**Arms:** R2's arms are soft at multiple levels and the robot always knows where its limbs are in space. They have redundant force sensing and R2 can safely work side-by-side with humans as it is currently doing on-board the International Space Station.

**Sensing and Perception:** R2 shares senses similar to humans: the ability to touch and see. These senses allow it to perform in ways that are not typical for robots today.

**Interface and Control:** R2 can function autonomously or it can be controlled by direct teleoperation. When functioning autonomously, R2 understands what to do and how to do it based on sensory input. The robot uses its vision, force, and tactile sensing to carry out tasks in real time.

**VISION:** Infrared cameras for depth perception and 4 visible light cameras to provide stereo vision as auxiliary cameras

**NECK:** 3 degrees of freedom

**ARMS:** 7 degrees of freedom and approximately 2'8" long

**HANDS:** 12 degrees of freedom  
4 in the thumb and 3 each in the index and middle fingers

**TORSO:** R2's brain

**FINGERS:** 5 pounds grasping force/finger. A minimum of 20 lbs. across the hand.

**R2 SYSTEM:** Over 50 patents and patent pending technologies, 50 actuators, 350 sensors, and 42 independent degrees-of-freedom



R2 can do all of these things side-by-side with humans. The robot moves at human speed. Its skin is soft and padded and it can sense through its safety systems when it comes into contact with someone. There are torsion springs inside the robot that provide force control – so when a person pushes away the robot's arm, it gives easily. And the robot always knows where its limbs are, making it safe for operation around people and delicate equipment.

## APPLICATIONS

The technology has several potential applications:

**Logistics and distribution** – allows for much more complex and delicate operations that require a more sophisticated level of interaction

**Industrial** – can operate equipment and machines designed for humans, like drills or forklifts

**Medical** – can handle time-consuming tasks of counting, sorting, inspecting, and processing

**Hazardous, toxic, or remote environments** – can be an invaluable tool for land mine detection, bomb disposal, waste recycling, and more

National Aeronautics and Space Administration

Michelle P. Lewis

Johnson Space Center

2101 NASA Parkway  
Houston, TX 77058  
281.483.3809  
jsc-techtran@mail.nasa.gov

<http://technology.nasa.gov/>

[www.nasa.gov](http://www.nasa.gov)

NP-2014-08-1135-HQ

NASA's Technology Transfer Program pursues the widest possible applications of agency technology to benefit US citizens. Through partnerships and licensing agreements with industry, the program ensures that NASA's investments in pioneering research find secondary uses that benefit the economy, create jobs, and improve quality of life.

MSC-24740-1

