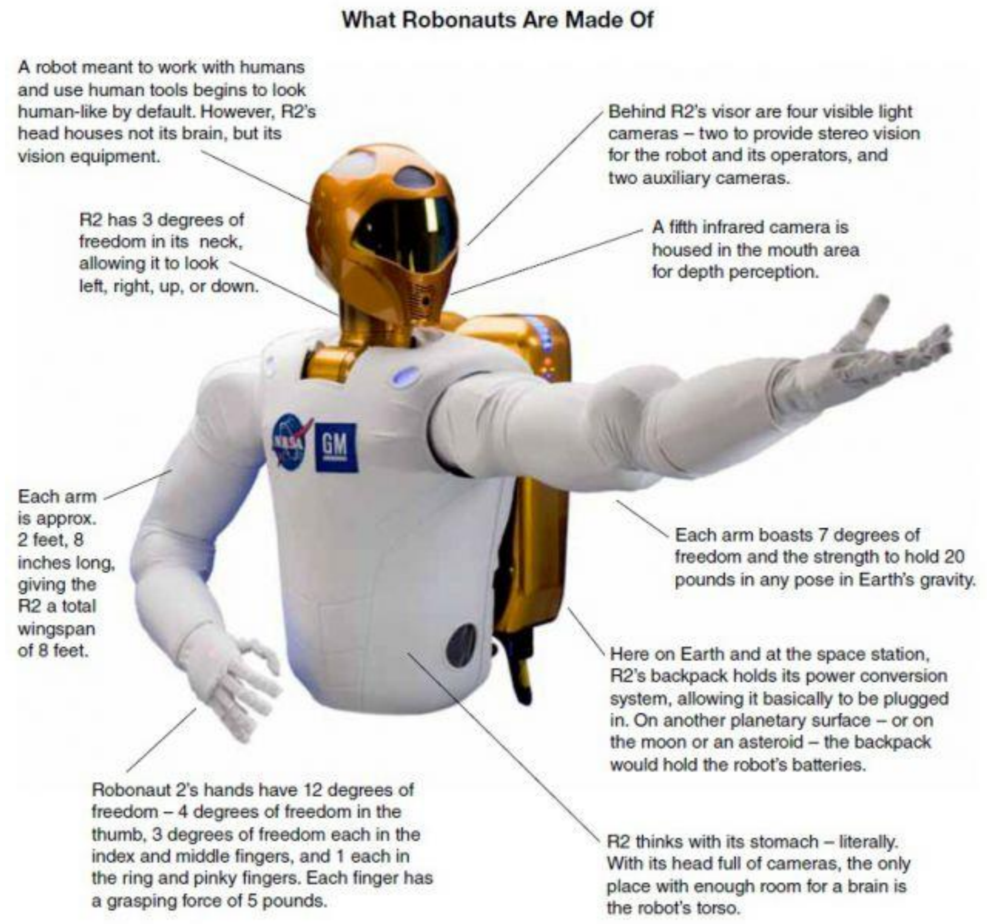
NASA's robonauts are designed to help astronauts in space

Robonaut 2 Technology Suite Offers Opportunities in Vast Range of Industries

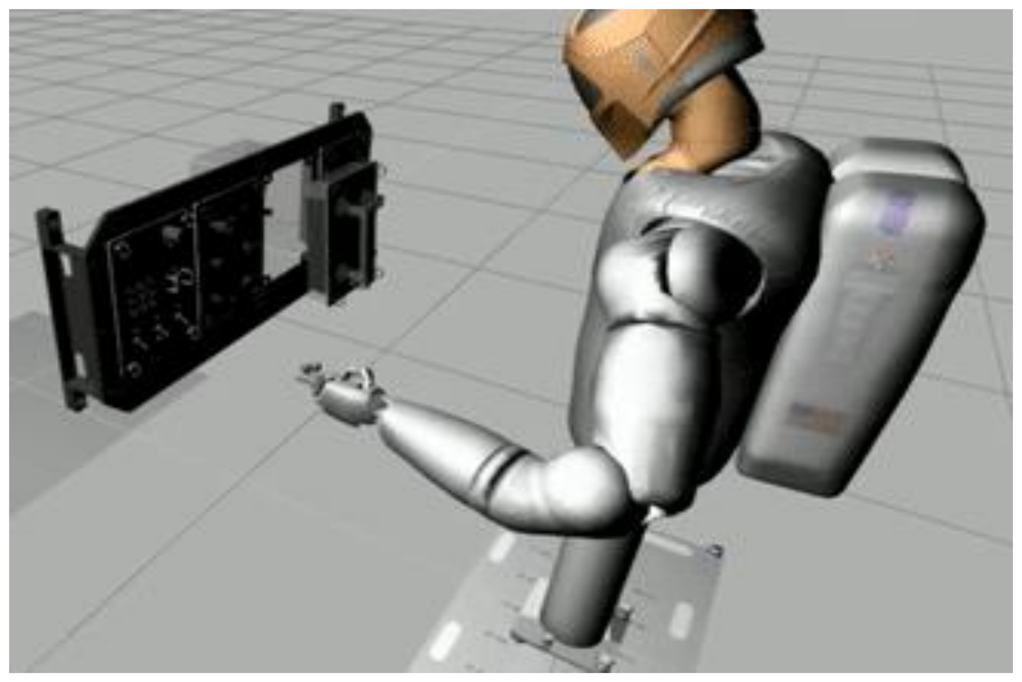
WHAT IS A Robonaut?

- A *Robonaut* is a dexterous humanoid robot built and designed at NASA Johnson Space Center in Houston, Texas.
- Robonaut will expand our ability for construction and discovery. Central to that effort is a capability we call dexterous manipulation, embodied by an ability to use one's hand to do work, and our challenge has been to build machines with dexterity that exceeds that of a suited astronaut.
- R2 is made up of multiple component technologies and systems -- vision systems, image recognition systems, sensor integrations, tendon hands, and much more.



PRODUCT OVERVIEW

Simulators: Gazebo 4
Sensors, Actuators: 2x Cameras, 1x Laser, Four Propellers
Movement: TF and inverse kinematicIts a fully articulated robot used for Space Operations in the ISS.
In this simulation you can launch a placement panel test, but are many other tests available.
This is the perfect platform for deep-robotics learning and manipulation tests.
Developed by : Nasa simulation core and The Construct the magnetic-taskboard test.



Here you can access to the simulations used to test the Nasa Robonaut 2.

CONTROL STRATEGY

As for the control law of *arm*, the dual-priority control described in the previous subsection is defined as follows. First, consider the
equations of motion for the full system of manipulators.

$$M\ddot{q} + c + g - \tau_e = \tau \qquad (1)$$

M is the joint-space inertia matrix, q is the column matrix of joint angles, c is the column matrix of Coriolis and centripetal generalized forces, g is the column matrix of gravitational generalized forces, and τ and τ_e are the column matrices of actuated and external torques, respectively.
Second, consider the desired closed-loop impedance relations for both the operational and joint spaces.

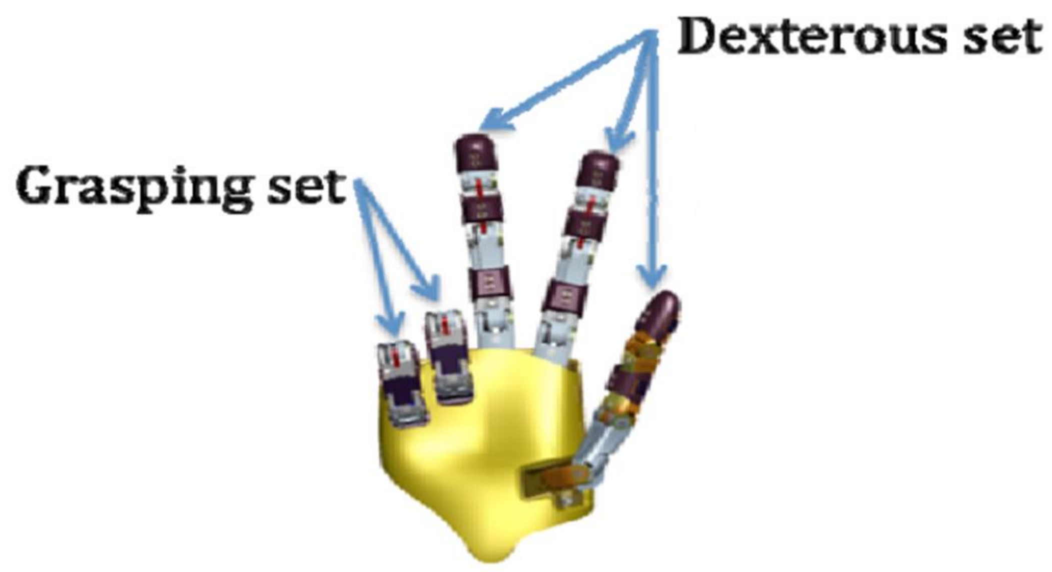
$$M_o\ddot{x} + B_o\dot{x} + K_o\Delta x = F_e \qquad (2)$$
$$M_j\ddot{q} + B_j\dot{q} + K_j\Delta q = \tau_e$$

$M_o, B_o,$ and K_o represent the desired operational-space inertia, damping, and stiffness matrices, respectively. M_j, B_j, and K_j represent the desired joint-space inertia, damping, and stiffness matrices, respectively. x and F_e represent the operational-space coordinates and corresponding external forces, respectively, and the Δ indicates the error in the respective variable with respect to its desired value.
To eliminate the need for sensing external torques, the impedance inertias are set to the passive inertia of the system: $M_o = M, M_j^{-1} = JM^{-1}J^T$. The full solution for this dual-priority impedance control law is presented in [14].
For the sake of the implementation, the following approximation is employed in R2 to eliminate the need for the inertia matrix.

$$\tau = -J^T(B_O\dot{x} + K_o\Delta x) - N\left(B_j\dot{q} + K_j\Delta q\right) + g$$
$$N = -J^+J \qquad (3)$$

J is the Jacobian matrix mapping joint velocities to operational-space velocities and N is the null-space projection matrix for J.
A closed-loop analysis shows that this control law provides the desired joint-space impedance relation (2) projected into the null-space; in the range-space, it provides the desired operational-space impedance relation (2) with a disturbance from the null-space dynamics. The effects of this disturbance, as well as the effects of neglecting the Coriolis forces and the derivative of J, are negligible for R2's range of speeds.
A similar relationship to (3) is used for the hybrid force/impedance mode. A null-space projection matrix for the force task Jacobian is used to project the primary and secondary tasks into the force task's null-space.

As for the control law of *finger*, the fingers are divided into a dexterous set used for manipulation and a grasping set used to maintain stable grasps while working with large tools. The dexterous set consists of two, three DOF fingers (the index and middle) and a four-DOF opposable thumb. The grasping set consists of two, one DOF fingers (the ring and little finger). All fingers are shock-mounted within the palm, giving the hand rugged grasping options.
The four DOF R2 thumb, optimized to achieve a very human kinematic layout, is the same scale as a human thumb. The design also provides the thumb with significantly greater strength than the opposing fingers.



The robot has the flexibility to use human tools and adapt to the task at hand, whether serving as an assistant or stand-in for astronauts during spacewalks or handling tasks too difficult or dangerous for humans.

For industrial environments, this dexterity is also a key feature, as R2 has the flexibility to roll something out, hold a drill, use a pair of wire-cutters, or sort through a bin of parts. In addition, R2 can handle factory work that is ergonomically difficult, repetitious, fatiguing, or unsafe.

DEVELOPMENT

R2 was designed and developed by NASA and General Motors with assistance from Oceaneering Space Systems engineers to accelerate development of the next generation of robots and related technologies for use in the automotive and aerospace industries.

R2 is a state of the art highly dexterous anthropomorphic robot. Like its predecessor Robonaut 1 (R1), R2 is capable of handling a wide range of EVA tools and interfaces, but R2 is a significant advancement over its predecessor.

R2 is capable of speeds more than four times faster than R1, is more compact, is more dexterous, and includes a deeper and wider range of sensing.

Advanced technology spans the entire R2 system and includes: optimized overlapping dual arm dexterous workspace, series elastic joint technology, extended finger and thumb travel, miniaturized 6-axis load cells, redundant force sensing, ultra-high speed joint controllers, extreme neck travel, and high resolution camera and IR systems.