



Space Assembly, Maintenance, and Servicing

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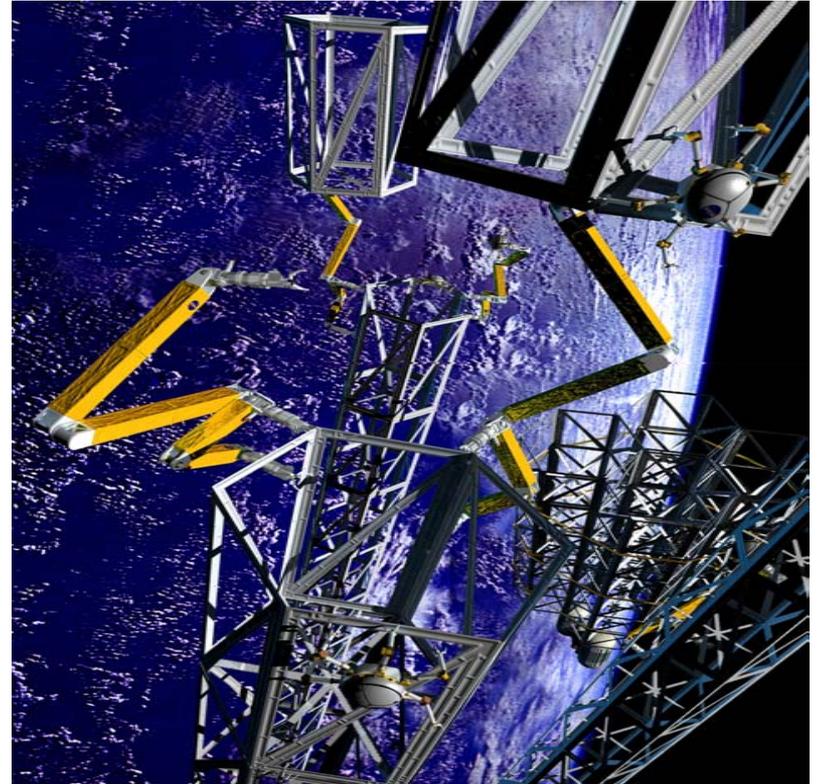
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Robot for Space Assembly

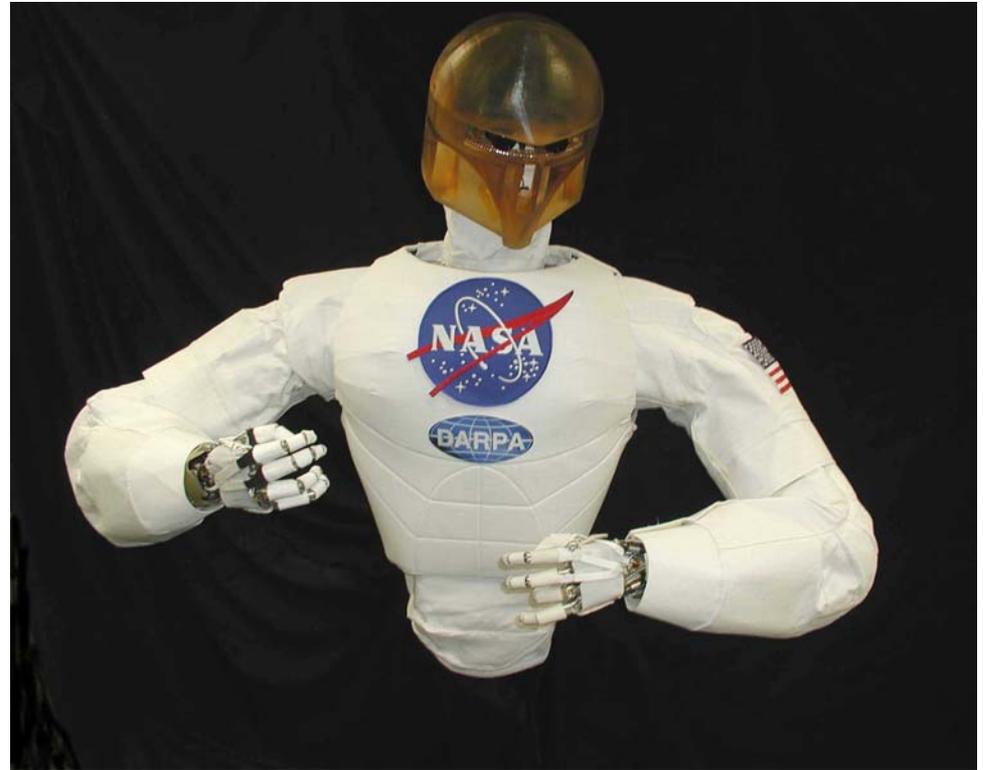
- Space Solar Power Satellites are going to need teams of robots for Assembly, Maintenance and Servicing support
- These robots will need capabilities well beyond those available in current space robots, and even well beyond ground based robots.



ROBONAUT

Mission

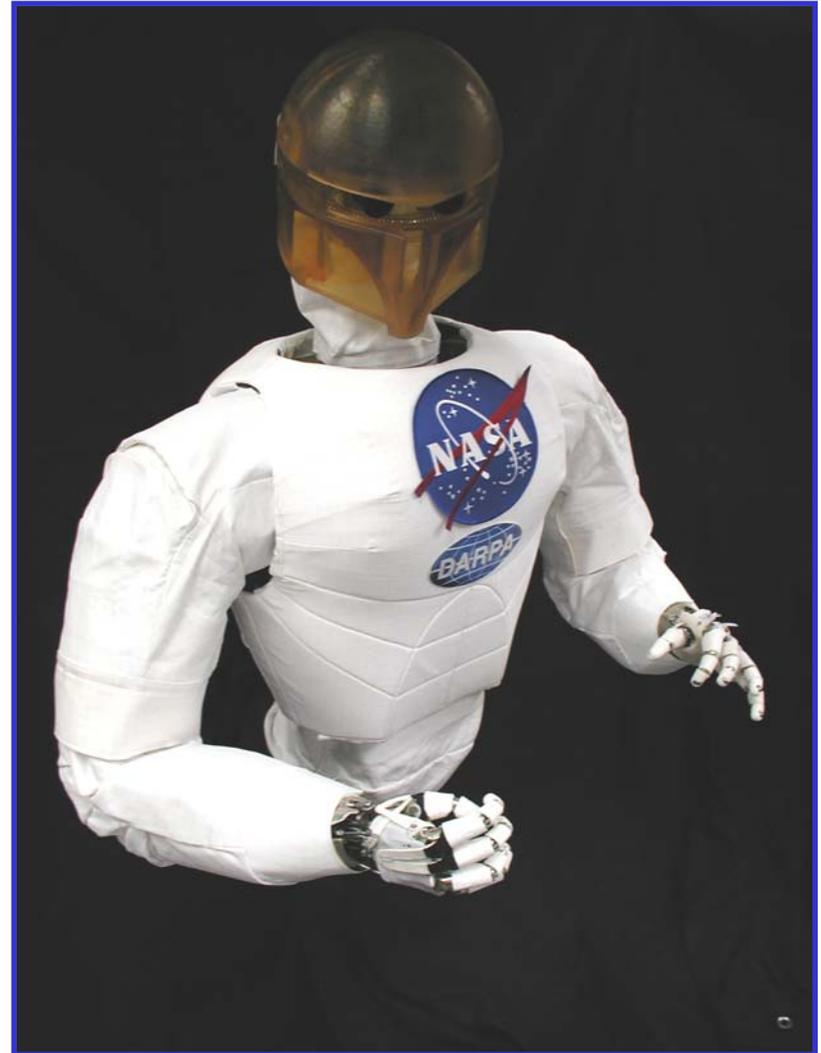
Provide robots for on-orbit and planetary surface activities that assist and augment human astronauts.



- Technology Objective:
 - Develop a space robot with dexterous capability exceeding that of a suited Astronaut; capable of providing assistance during space maintenance and exploration activities, performing setup & close out work, and providing a Minuteman capability, on-call for emergencies.
 - The Dexterous robot will work with same tools and infrastructure as human astronauts to reduce costs and increase safety

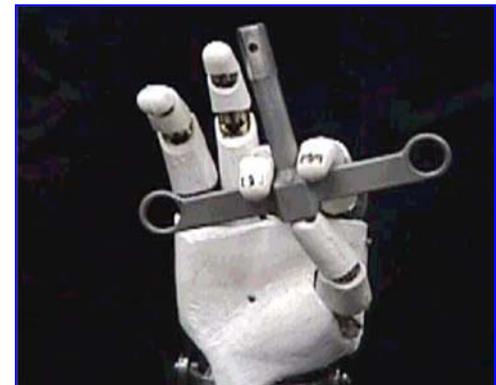
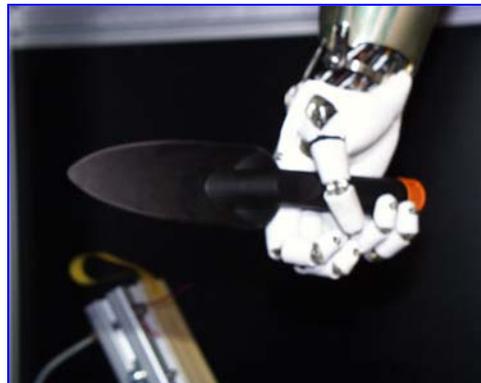
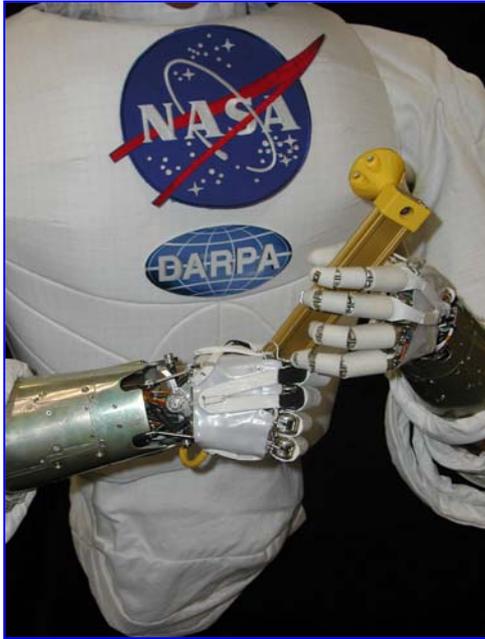
ROBONAUT Overview

- Sophisticated upper body dexterity system
 - 7 Degree of Freedom (DOF) human scale arms
 - 5 Fingered dexterous hands
 - 2 DOF neck
 - 3 DOF Waist
- Massive sensing modes
 - 150 sensors per upper limb
 - Stereo vision
- Versatile, capable system
- Control modes for both autonomy or human control

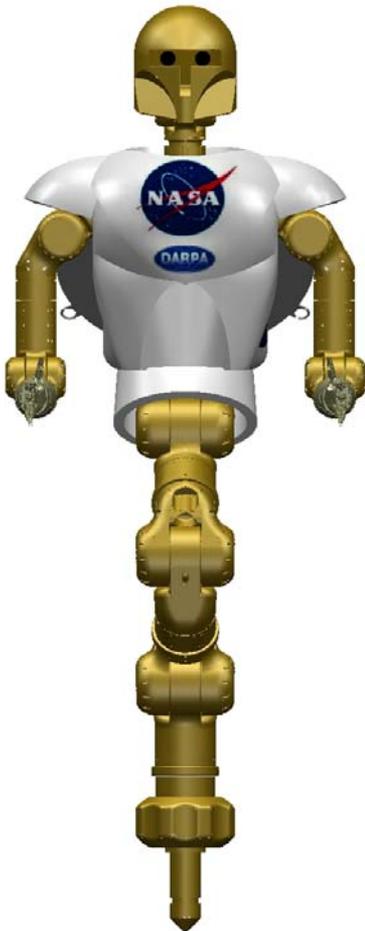


Tool Handling

- *Robonaut* is designed, first and foremost, to work with tools.
- The hand is dexterous enough to handle a wide variety of tools of varying shapes and size.



ROBONAUT: Anatomy for 0g Work



Stereo Vision
Articulated Neck

Embedded computers
RMS Interface

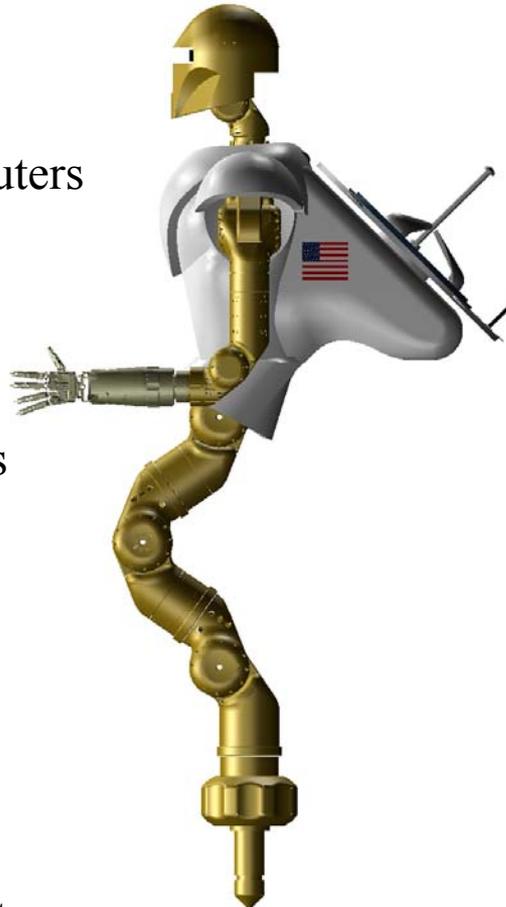
Dexterous Arms

5 Fingered Hands

Stabilizing Leg

Load Limiter

ISS Socket Adapter



RMS Interface



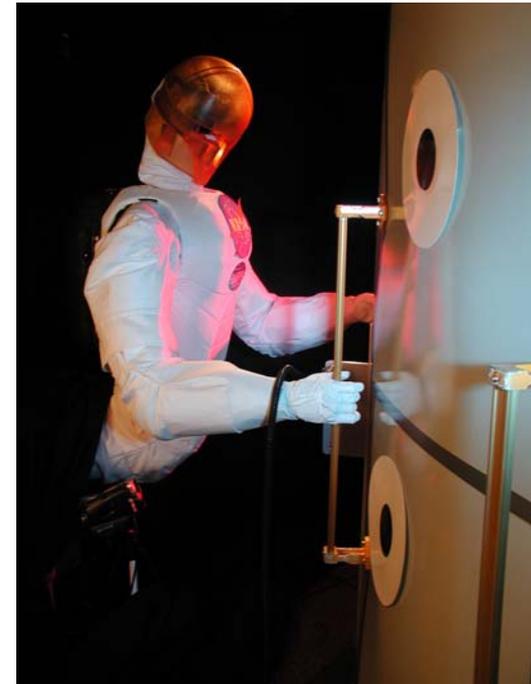
Shuttle RMS



Space Station RMS

Assembly & Servicing in Space

- Robotic Assembly and Servicing activities being examined from a variety of viewpoints
- Mobility, mating/de-mating parts, attaching connectors, etc. all technical challenges for a space robot.



Automating *ROBONAUT*

- In some situations, it is preferable to allow the robot to handle some tasks without direct human control.
- On-going development will add intelligent systems technology to *Robonaut* allowing a greatly reduced human role and increased autonomy for the robot.
- Limited intelligence has already been added for low level autonomy functions such as automated grasping, visual object recognition, and voice recognition.



Photo of *ROBONAUT* mating cables