

Spacehand: The Next Generation On-Orbit-Servicing Tool

DLR-RM – Institute of Robotics and Mechatronics

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Knowledge for Tomorrow



Agenda

- German Aerospace Center
- Robotics and Mechatronics Center
- Dexhand
- Spacehand
- Outlook



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German Aerospace Center (DLR) / Robotics and Mechatronics Center (RMC)

- 8000 employees
- 33 institutes
- 16 locations in Germany and also in Brussels, Paris, Tokyo, Washington D.C.
- Main sectors: Space, Aerospace,
Transport, Energy, ...



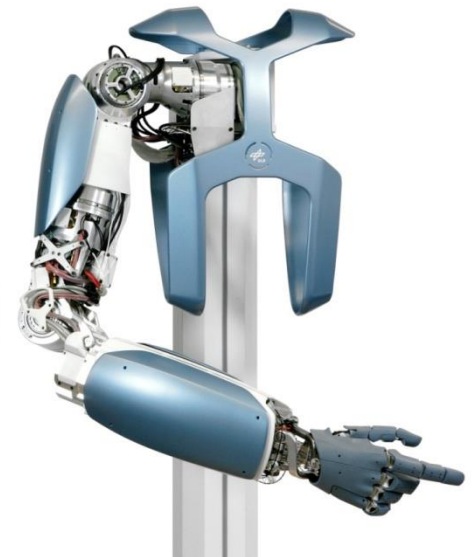
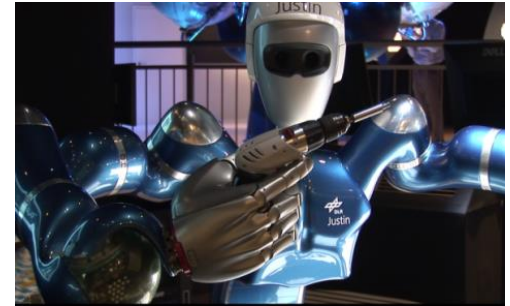
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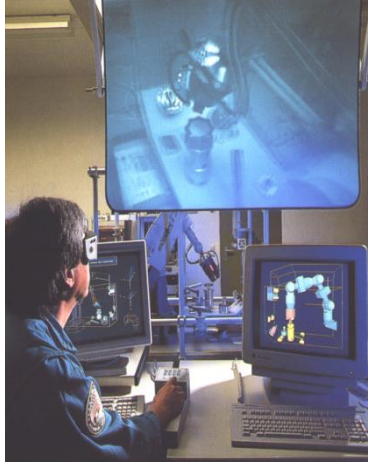


DLR-RMC: Activities in Robotics

- LWR : 7 DOF arm
- Humanoid Robotics (Justin / Hand Arm System)
- Medical Robotics
- Space Activities
- Collaborative Helicopters
- Autonomous car



DLR-RM: Activities in Space Robotics - a short overview



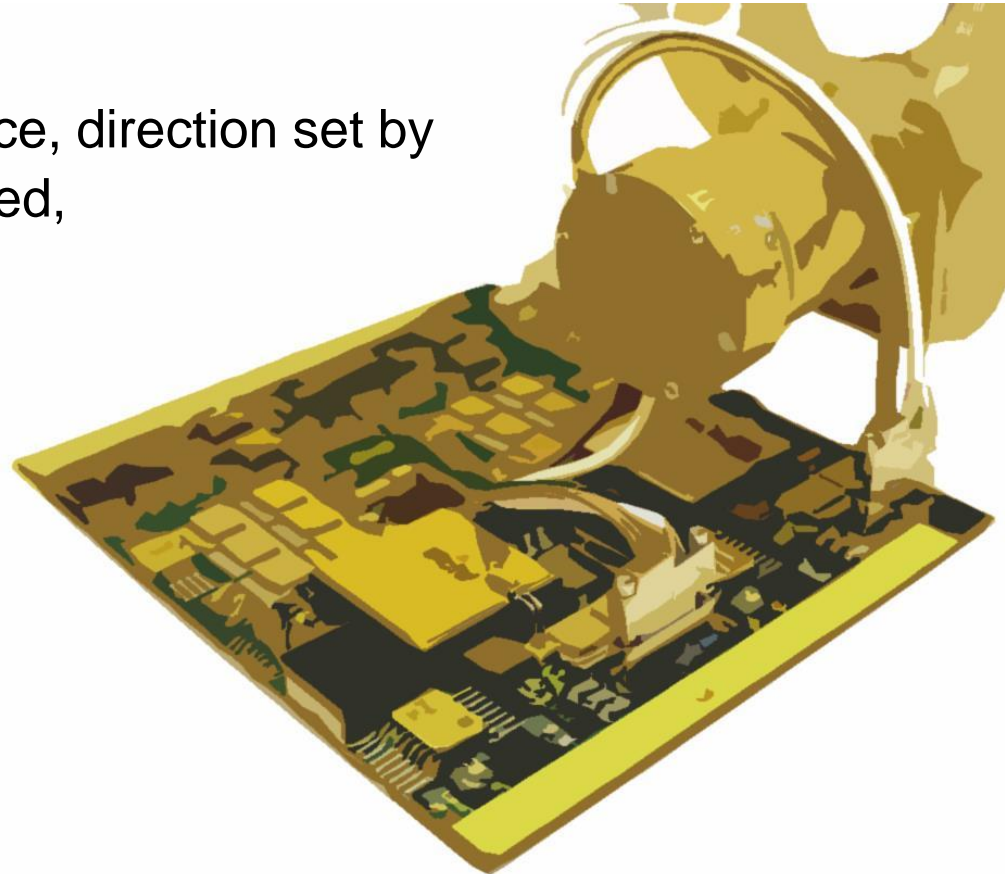
- ROTEX (1993): The first remotely controlled robot in Space (D2 mission)
- GETEX / ETS-VII (1999): Video sensor controlled pick and place operations
- ROKVISS (2005 – 2010): Robot at the outside of the ISS based on LWR technology
- MASCOT (Now ongoing): Contribution with the Mobility unit
- KONTUR-2 (Now ongoing): Telepresence experiments (ISS ↔ Earth)
- CAESAR: Robot Arm for On-Orbit Servicing
- Spacehand: 4-finger Hand for On-Orbit Servicing



DLR-RMC: Activities in Space Robotic

MASCOT

- Hop-Mechanism for low gravity asteroids
- Full redundant motor PCB
- Motor controller in native VHDL
- Hopping parameters like distance, direction set by acceleration, deceleration, speed,



DLR-RMC: Activities in Space Robotic

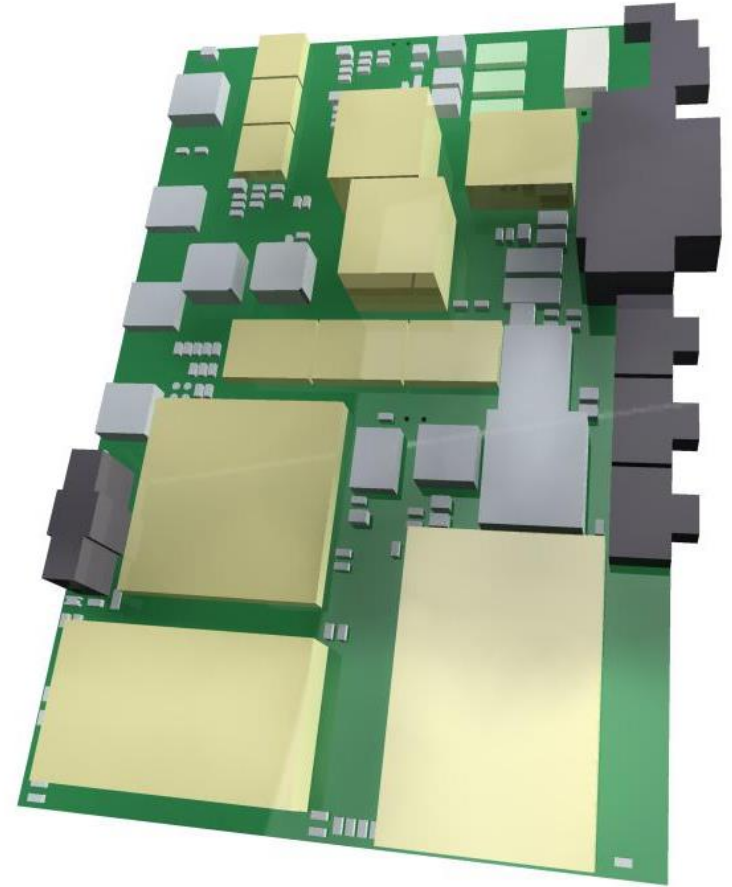
LRU

- Size: 114cm × 74cm × 94cm
- Weight: ca. 30kg
- DOF: 12,
• 4 Wheels
• 4 steering
• 2 elastic joints
- Speed: 1,11m/s = 4km/h
- Special: Automatic planning

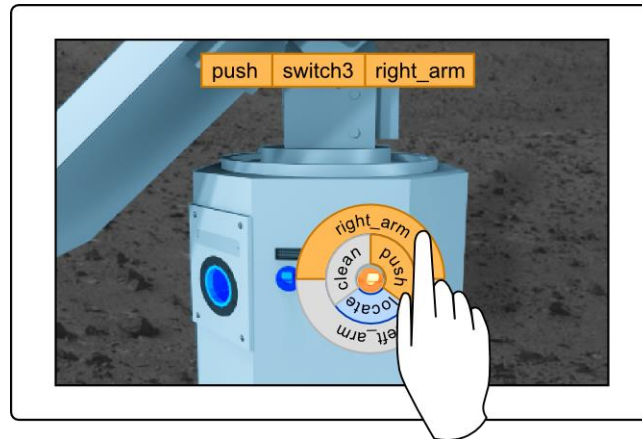


Universal Motor-Controller

- Small size of 65x111mm
- Motor power up to 300W
 - +12 to +70V
- Several communication possibilities:
 - EtherCAT, Spacewire, RS422
- Resolver interface
- Radiation Hardened up to 40kRad
- SEL LET threshold of 80 MEV*cm²/mg



Justin - METERON





DLR Robot Rollin' Justin
Robotics and Mechatronics Center, Oberpfaffenhofen, Germany



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History: DEXHAND: what needs ?

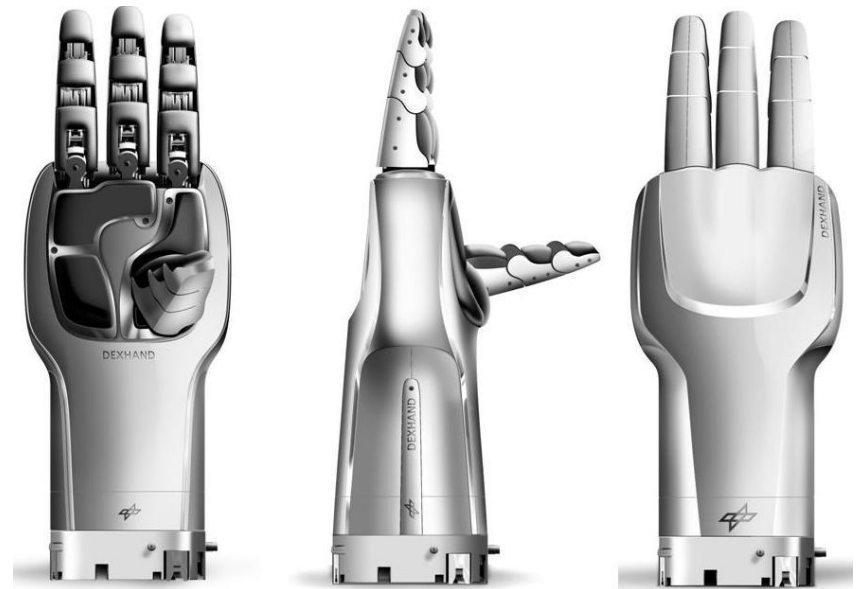
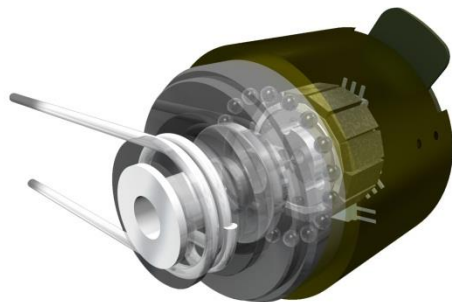
- Anthropomorphic four fingered, torque controlled robot hand
- Size of an EVA glove
- Survive 6 months in external ISS environment
- Autonomous and tele-manipulation operation
- Tasks are computed on the DEXHAND itself

Requirement:	OPS-1
The DEXHAND shall be able to grasp the following EVA tools: <ul style="list-style-type: none">• Pliers, and support their operations• Scissors, and support their operations• Small cutter and support its operations• Brush, and support its operations• Hammer, and support its operations• Scoop, and support its operations• Cutter, and support its operations• Tether(s), and support its operations• Allen wrench, and support its operations• Pistol grip tool (automatic screw driver) and support its trigger switch actuation	
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Comment: Successful operation of the tools implies force closure of the grasp. Note that preferably form closure should be achieved.	



History: DEXHAND: design

- Highly integrated mechatronic concept
- Torque controlled joints (Impedance) at 1kHz



History: DEXHAND: result

- Mass of about 3,5kg
- Storage volume of 270mm * 130mm * 140mm
- Peak Power of 100W @28V, additional 20W for hibernation
- Operating voltage of 19V – 34V, nominal 28V
- CAN Bus Interface with service lines (Enable, Latchup...)





**Deutsches Zentrum
für Luft- und Raumfahrt e.V.**
in der Helmholtz-Gemeinschaft

Institute of Robotics and Mechatronics



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Spacehand: the new requirements

DEXHAND



CAN

LEO

6 months



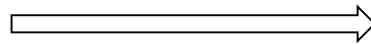
Spacehand: the new requirements

DEXHAND	Spacehand
 <p>CAN</p>	 <p>Spacewire</p>
<p>LEO</p>	<p>GEO</p>
<p>6 months</p>	<p>Several years</p>



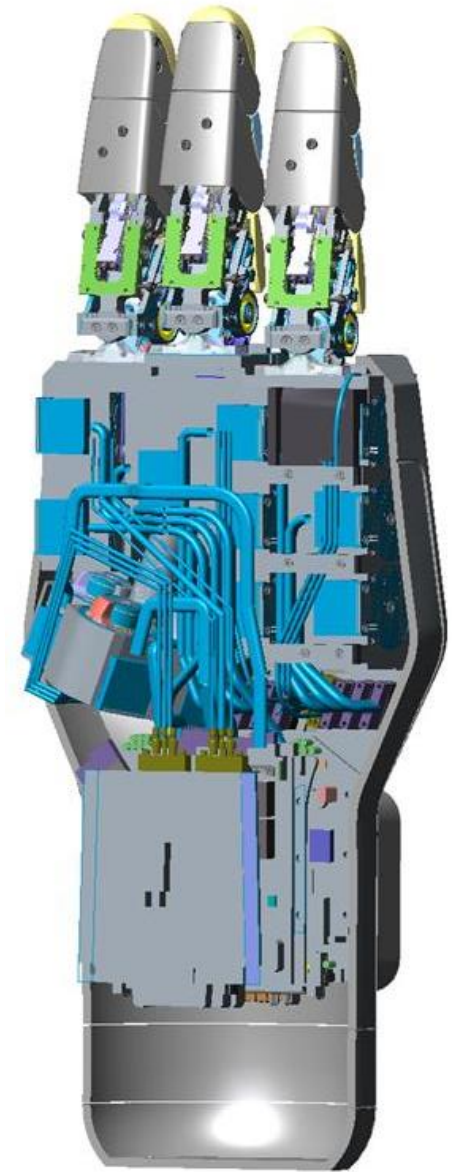
Spacehand: improved actuator module

- Changed from cable/PCB to Cable/Connector
- Added a “bridge” to simplify assembly

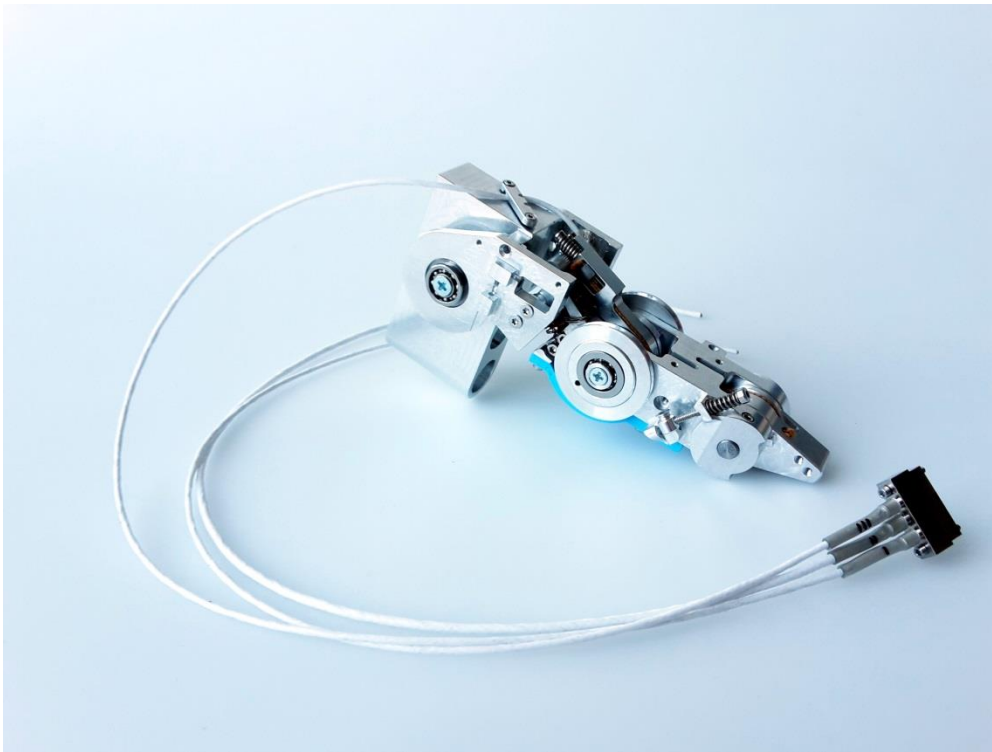


Spacehand: improved palm

- “Snap-in” fingers
- Reduced cable count
- Full Dorsal Access



Spacehand: improved palm



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Spacehand: Outlook

- Full EMC Test
- Shaker Test
- System Radiation Test at CERN
- Full TVAC-Test



Thank you for your attention.

Visit us at Booth 1119

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