

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 employee
- 33 institute
- 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



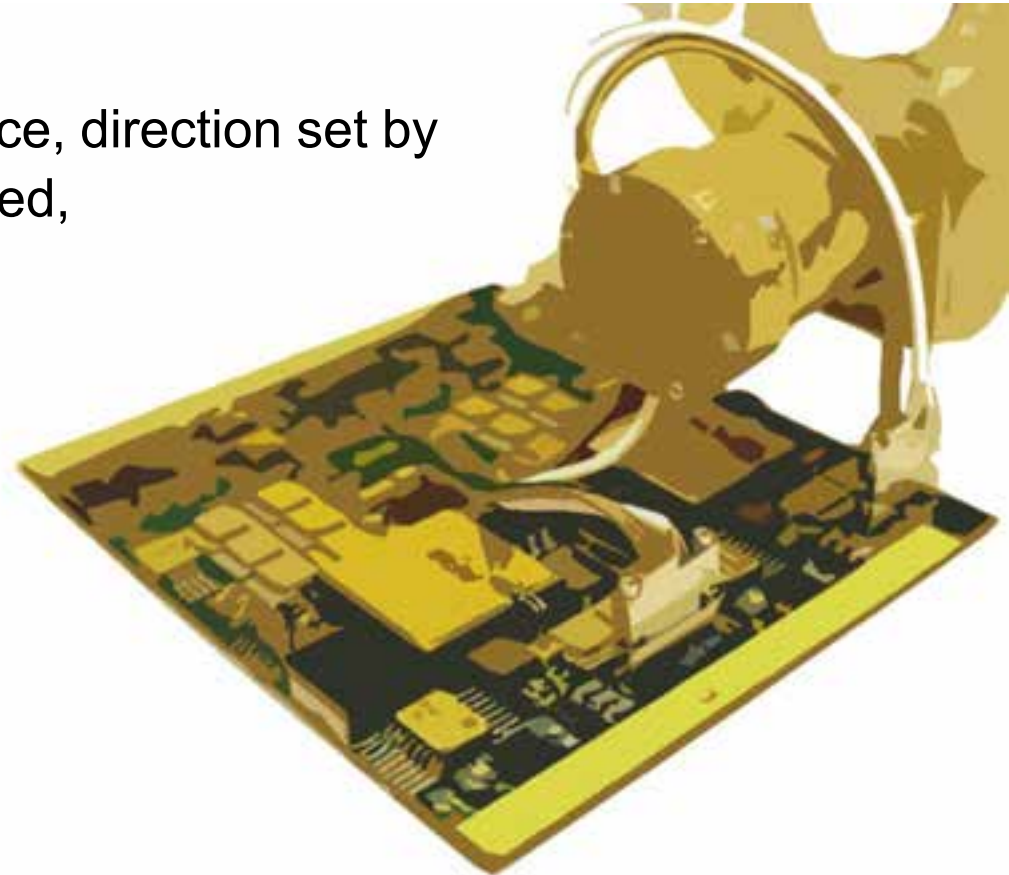
- ROTEX (1993): The first remotely controlled robot in Space (D2 mission)
- GETEX / ETS-VII (1999): Video sensor controlled pick and place operations
- ROKVISS (2005 – 2010): Robot at the outside of the ISS based on LWR technology
- MASCOT (Now ongoing): Contribution with the Mobility unit
- KONTUR-2 (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

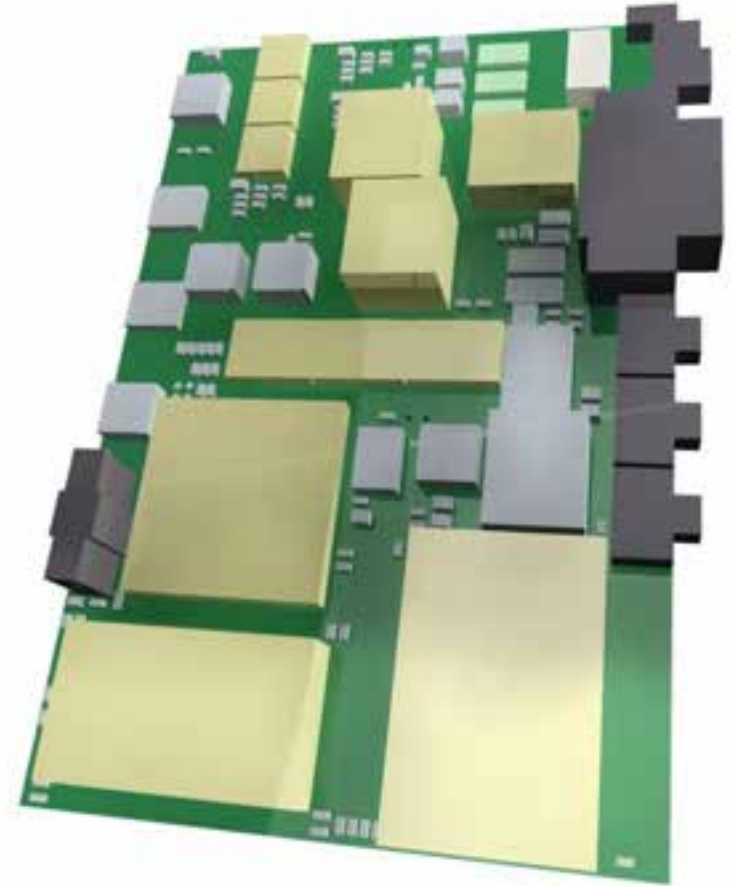
LRU

- 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

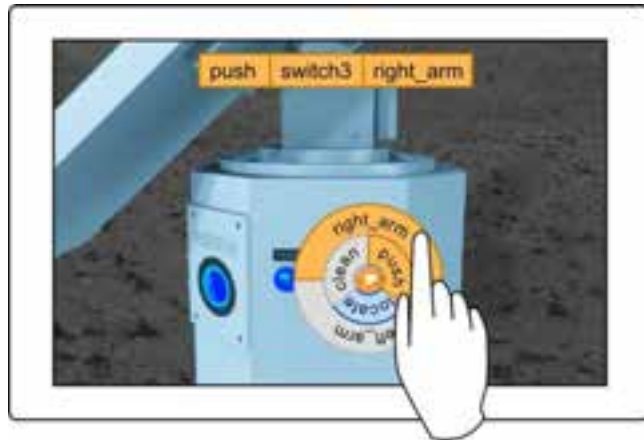


Universal Motor-Controller

- 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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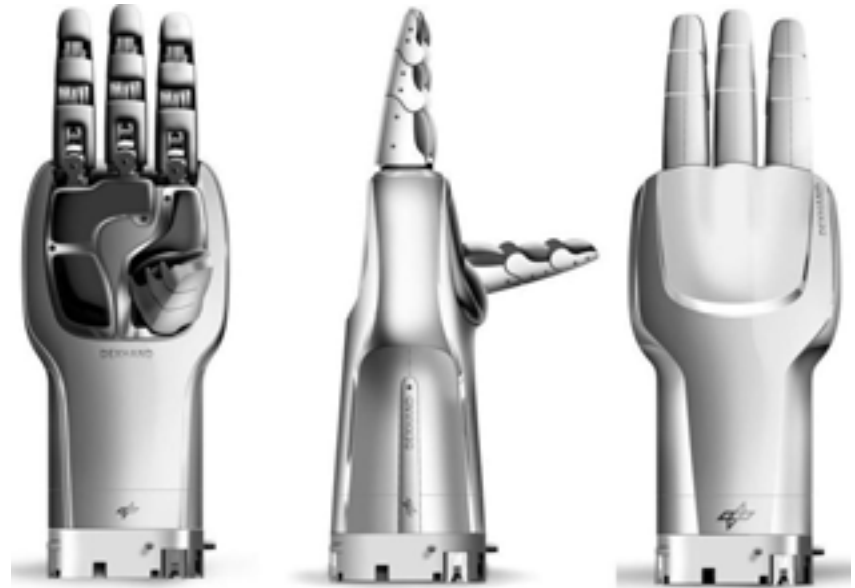
History: DEXHAND: what needs ?

- 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



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	



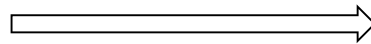
Spacehand: the new requirements

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



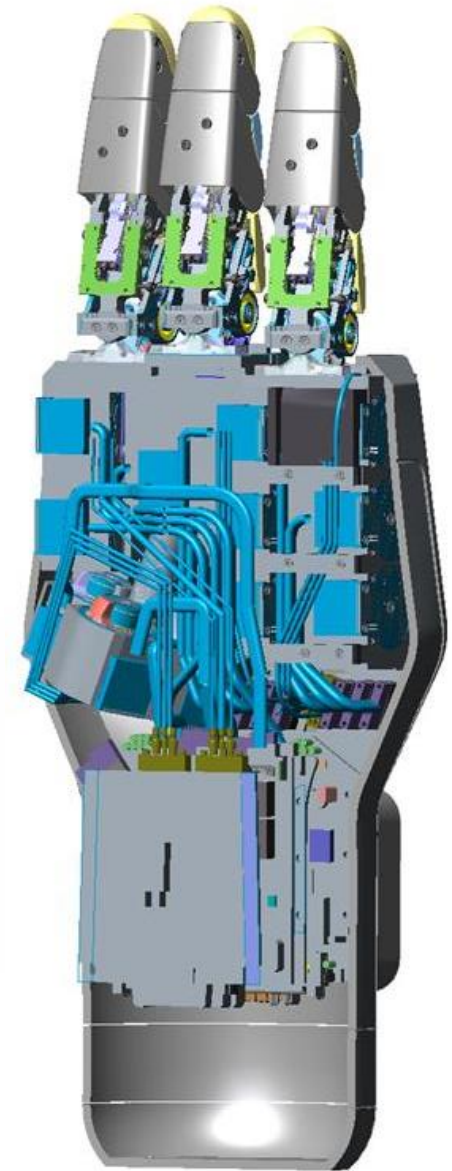
Spacehand: improved actuator module

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

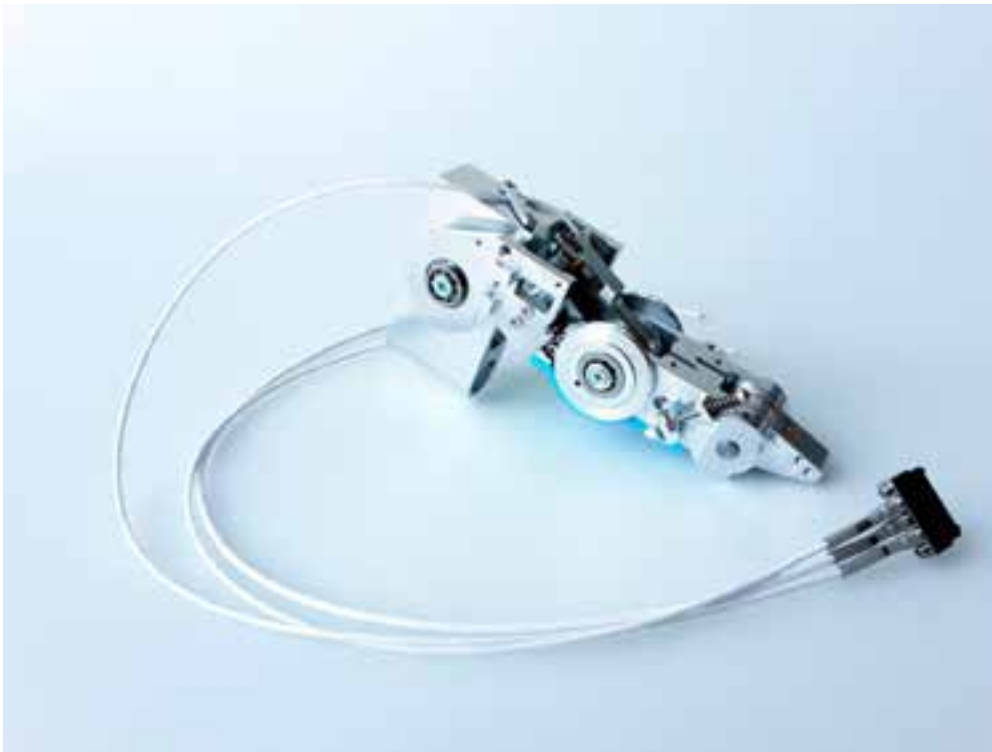


Spacehand: improved palm

- “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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