



Robotics and Automation for Hospitals and Medical Device Companies

Changing the world of medical robotics with “off the shelf solutions“!



The Challenge: Ping Pong Champion vs. KUKA AGILUS Robot

- **Timo Boll: The Perfect Match**

- Over recent years, Timo Boll and the KR AGILUS have squared up to one another in some tough contests. Today, things are quite different: the table tennis superstar and our robots form a perfect unit. <https://youtu.be/tlIJME8-au8>



KUKA – At the cutting edge of technology since 1898

- 2016/17 LBR Med
- 2013 LBR iiwa
- 2010 KR QUANTEC, KR C4, smartPAD
- 2007 RSNA Presentation of Siemens artis zeego
- 2001 FDA Clearance of the Accuray CyberKnife
- 1996 First open PC-based robot controller
- 1973 KUKA develops the world's first industrial robot with six electric motor-driven axes, called FAMULUS.
- 1956 KUKA revolutionizes welding technology: KUKA builds the first automatic welding systems and delivers the first multi-spot welding line to Volkswagen AG.
- 1898 Johann Josef Keller and (in German: **U**nd) Jakob **K**nappich found an acetylene factory in **A**ugsburg for lighting – subsequently for oxyacetylene welding and cutting technology.





The KUKA Group in Figures



+ 14,000 employees worldwide

40+ countries worldwide

≈ \$3.0B in Sales* (2015)



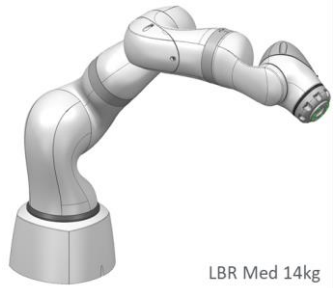
\$100+ Millions in R&D (4-5%)

Thousands of Customers



Robotics – Product Portfolio

LBR Med



LBR Med 14kg

**Medical
LBR
(7-14 kg)**

LBR iiwa



**Industrial
LBR
(7-14 kg)**

AGILUS



**Small
Robots
(-10 kg)**



**Low
Payloads
(5-16 kg)**



**Medium
Payloads
(30-60 kg)**

Quantec



**High
Payloads
(80-300 kg)**



**Heavy
Duty
(300-1300 kg)**



**Special
Models**



Aerospace Industry

- Aircraft are generally in use for decades. Nonetheless, the technology used in aircraft develops at a fast pace as do the requirements for the safety and comfort of the passengers

Automotive Industry

- KUKA is the world's leading provider of production systems in the automotive industry. With years of experience, we are the master in the design of flexible and efficient production processes.

Electronics Industry

- KUKA gives you an edge over the competition: our robotic automation solutions for the electronics industry can be implemented quickly, enable flexible production and make production processes more efficient.

Entertainment Industry

- KUKA can provide the entertainment solutions that meet the industry's demand for innovation.
 - KUKA Coaster: 6-axis robot as an amusement ride
 - Show Action is an ear-shattering explosion. Two cars are thrown through the air. Showtime in Hollywood!

KUKA Edutainment

- Learning by having fun with the aid of robots - KUKA robots lend themselves perfectly to this trend.

Medical Robotics

- KUKA's expertise extends from automation solutions that enhance efficiency in the operating room itself. In there, doctors, therapists and above all patients benefit from our core competence in robotics.

Welding Systems

- Industrial six-axis robot provides outstanding welding results.



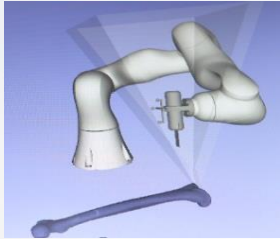
KUKA – your partner for medical robotics

- Simplified integration efforts, de-risk, accelerate development, regulatory processes
 - Develop and describe customer applications / references
 - Medical Team as main asset - speak same language, understand customer needs
 - Long time experience in medical - more than 17 years with over 1,500 systems integrated
 - Scalable to meet customer's market
 - Global presence with local support
 - Life-cycle management
 - Customizable applications, interfaces
- Integration - onsite support from design through implementation
- Leader in HRC standards; extensive knowledge base





Robotic Operating Room of the Future



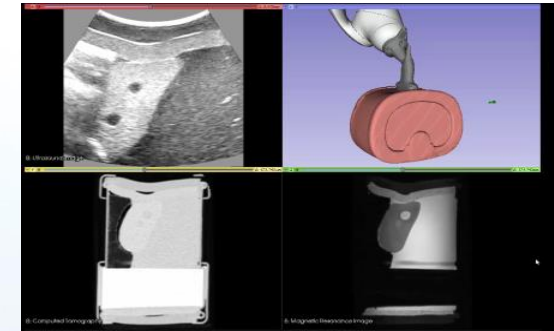
Assisted and Guided Therapy/Interventions



Combining
Components and Data
into
Solutions and Medical Workplaces



Multimodal Interventional Imaging



Robotic Patient Positioning



Robotic Patient Positioning



Accuray Robocouch



BEC examove 6C



Optivus-Couch



Forte-Couch



BEC examove 7F

Robotic Patient Positioning



Accuray Robocouch



BEC examove 6C



Optivus-Couch



Forte-Couch



BEC examove 7F



System Partner for Radiation Therapy



- Tumors are treated using a robot-guided LINAC (emission of high-energy X-ray radiation). Compared with conventional systems, this allows extremely flexible positioning of the LINAC around the patient and thus optimal radiation angles.
- KUKA supplies RoboCouch control and mechanical components for patient positioning.

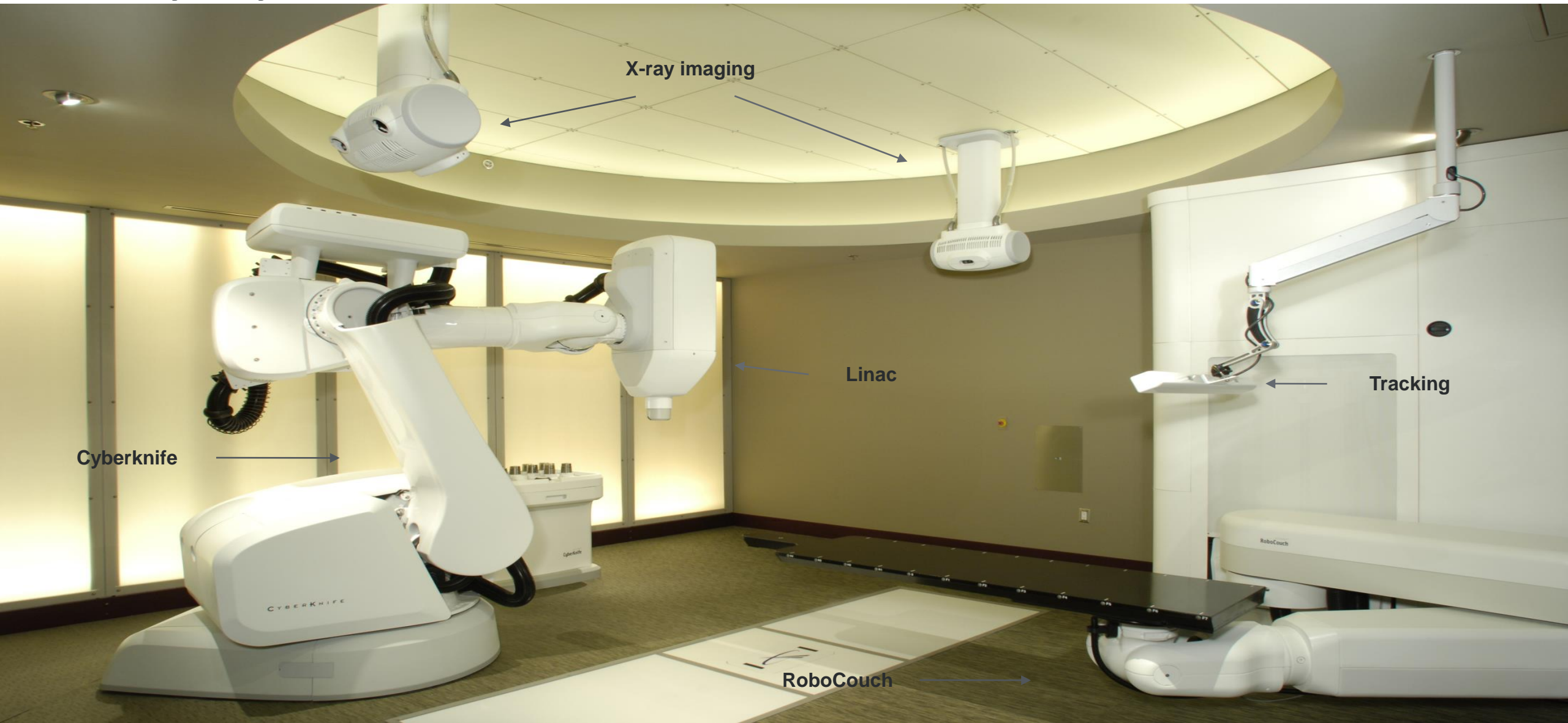
Copyright by Accuray

Siemens Artis Zeego



- KUKA delivered the robot technology for this, the world's first robotic angiography system. In order to take X-ray images, a C-arm is installed on the KUKA robot.
- Fast motions and versatile positioning options allow for high flexibility for patients and doctors as well as for a rapid switch from interventional to surgical use.
- **Installed base: more than 650 units worldwide**

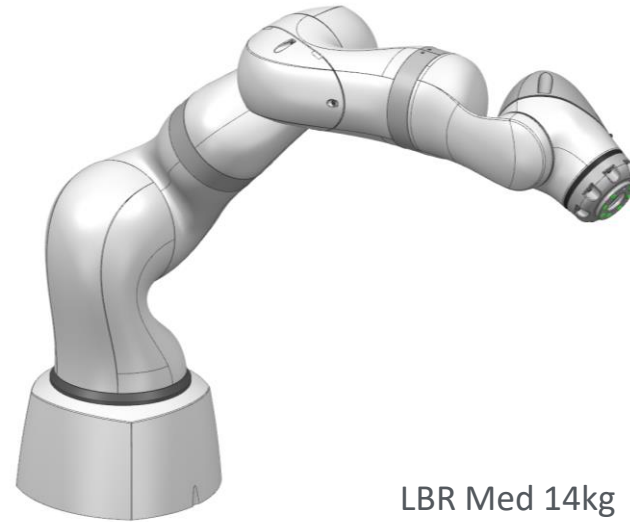
Accuray - Cyberknife



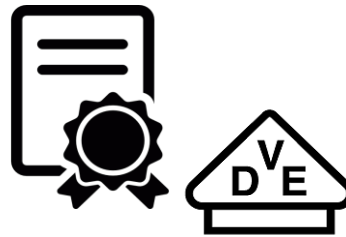


LBR Med

- CB-Certificate is provided with the LBR Med
- Component developed in alignment to the MDD standards
- CE-Labeling for EMC (IEC 60601-1-2:2014) and RoHS-II (2011/65/EU)
- New base design for increased hygiene
- Cabling and mounting from below
- Media flange electrical inside
- smartPAD only for maintenance necessary
- Brakes are a safety feature only
- Medical Grade Controller Cabinet
- Version controlled software for medical customers only



LBR Med 14kg



Overview LBR Med

LBR Med = Robot + Robot Controller + Controller Software

- LBR Med is a robotic system
- Available in two variants:
 - LBR Med 7 R800 with 7kg payload and 800mm reach
 - LBR Med 14 R820 with 14kg payload and 820mm reach
- 7 Axis Robot
- Torque sensors in each axis
- Redundant safety system
- Area of application: Medical technology





R&D Platform

Tasks:

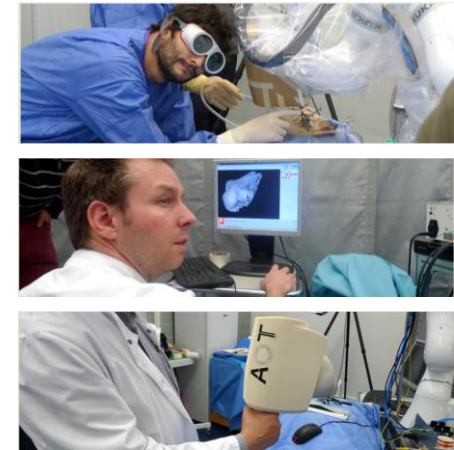
- Product Development
- Project Management
- Global Governance Solutions
- Corporate Research
- Product- & Portfolio Management
- Technological innovation & Revolutions

Objectives:

- Efficient and effective development of new robot technologies
- Providing user friendly steerings
- Providing reliable operating software for our robot systems

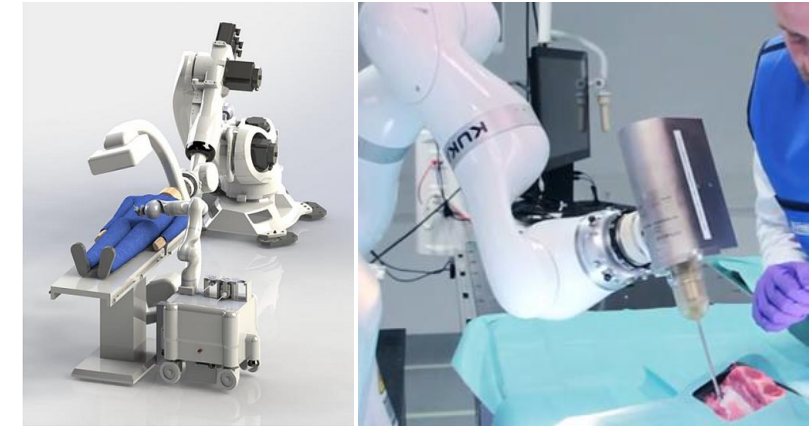


AOT AG – Laser-Osteotomy for Cranio-Maxillofacial Surgery



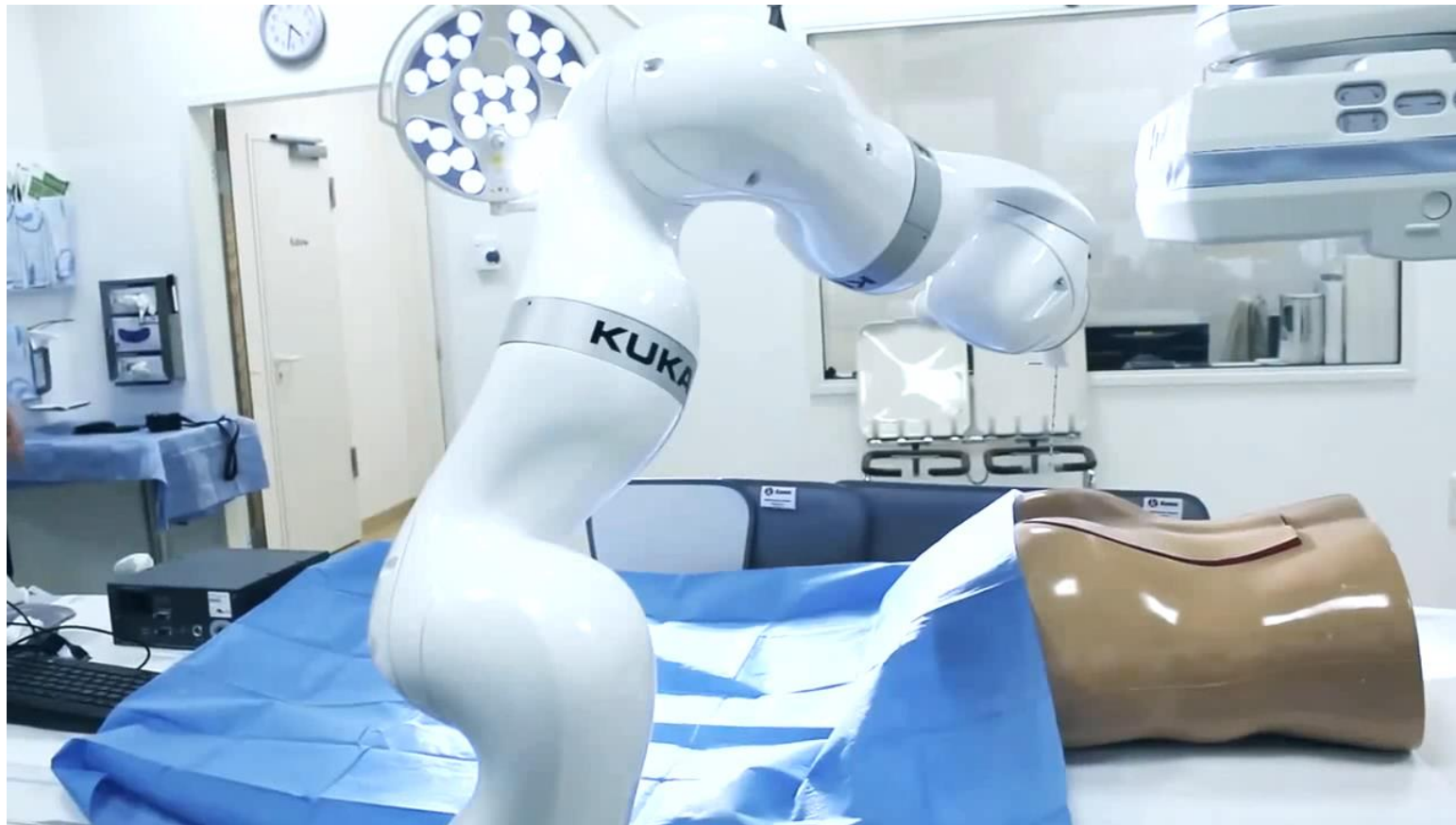
- Spin-Off from University Basel, founded 2011
- “Cold” Laser ablation for bone cutting, laser head is held by a KUKA LBR robot
- Functional cuts are planned based on preoperative CT images
- The cut lines are executed using the laser head and the robot
- **Authors:** A. Bruno, P. Cattin, P. Jürgens, H.-F. Zeilhofer

Robotic Kypho-Intra-Operative Radiation Therapy (IORT)



- Carl Zeiss INTRABEAM (small 50 kV x-ray source for intraoperative radiation therapy) used with KUKA LBR robot
- Integration with Siemens Imaging System Artis Zeego
- Target: precise treatment of metastasis in vertebra bodies
- **Authors:** J. Stallkamp et al.

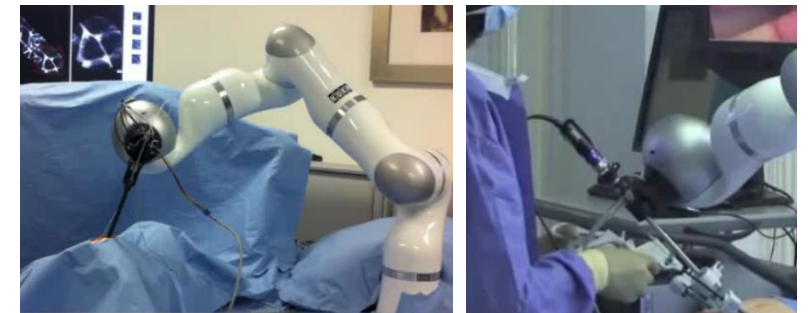
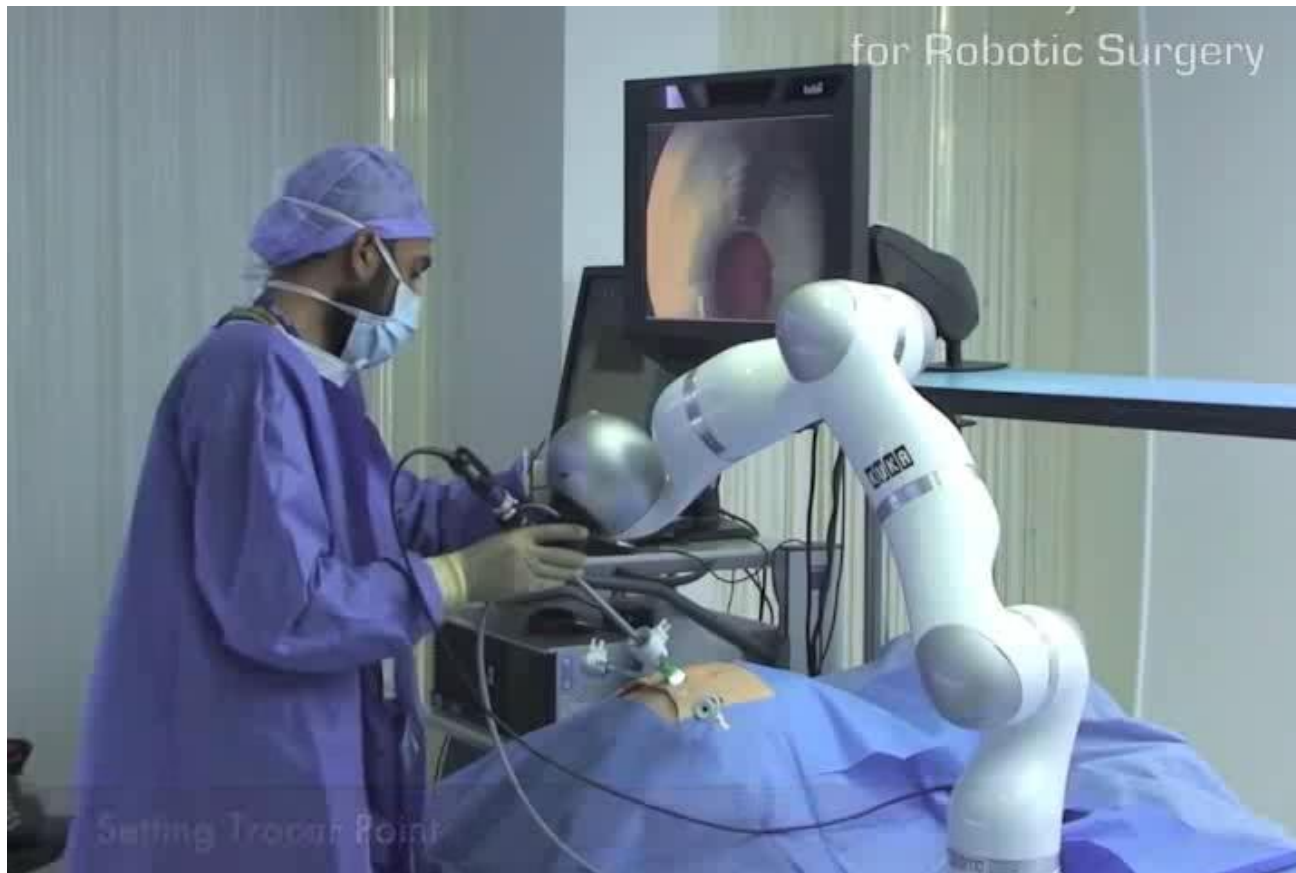
Molecular Intervention as Treatment of Patients with oligo metastasis



- Target: flexible System platform for minimal invasive, assisted molecular intervention
- Robot based stationary or on a mobile AGV-platform, cooperatively telemanipulate, autonomous support to approach target situs.
- Integration with Siemens Imaging System Artis Zeego
- **Authors:** J. Stallkamp et al.

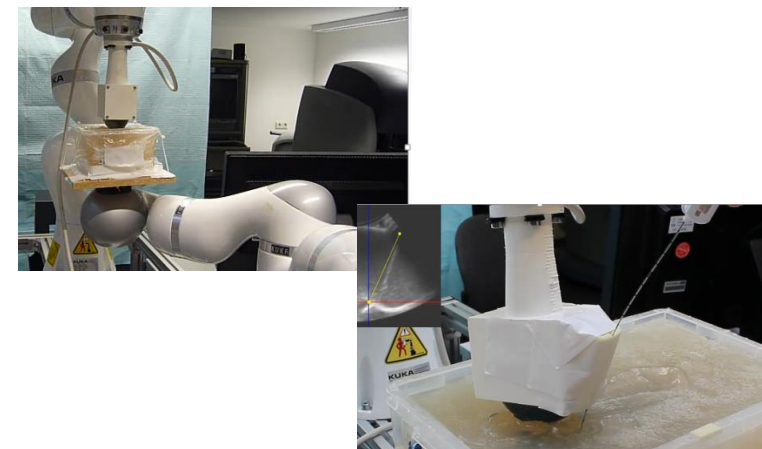
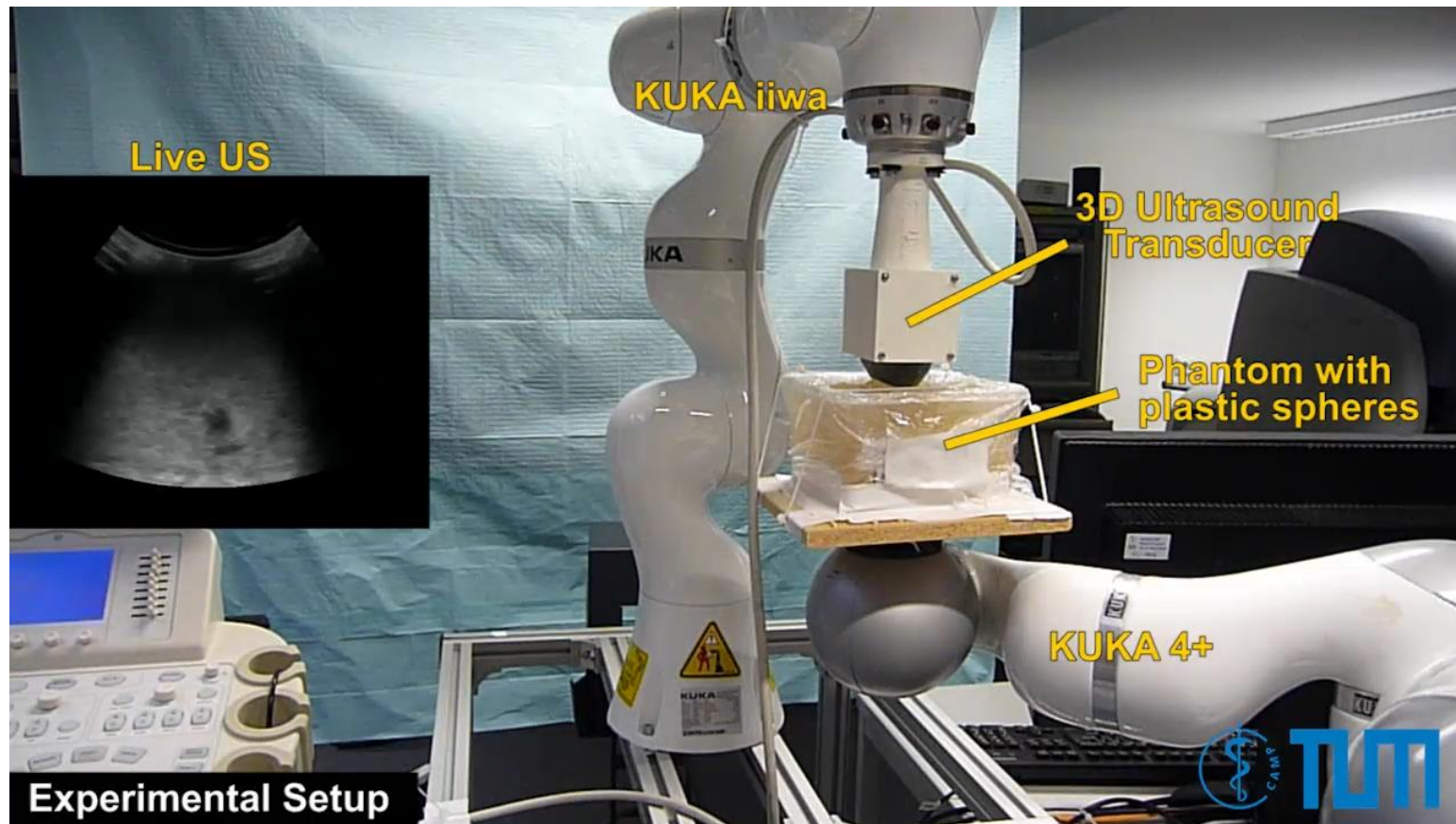


Gaze tracking for camera guiding



- Intelligent endoscope-holder with eye-tracking
- Hamlyn Centre for Robotic Surgery, Imperial College London
- **Authors:** K. Fujii, A. Salerno, k. Sriskandarajah, G.-Z. Yang

3D Ultrasound Registration with Real-Time Servo-Control



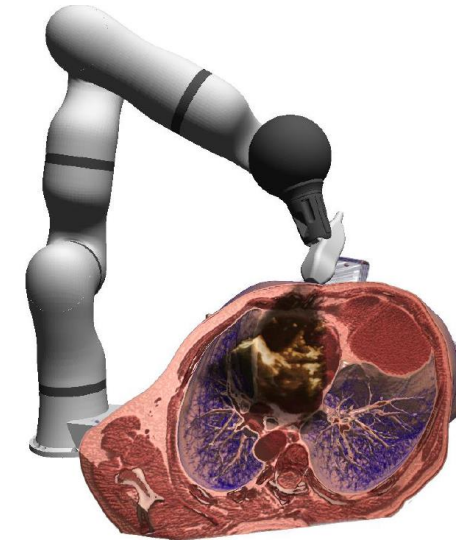
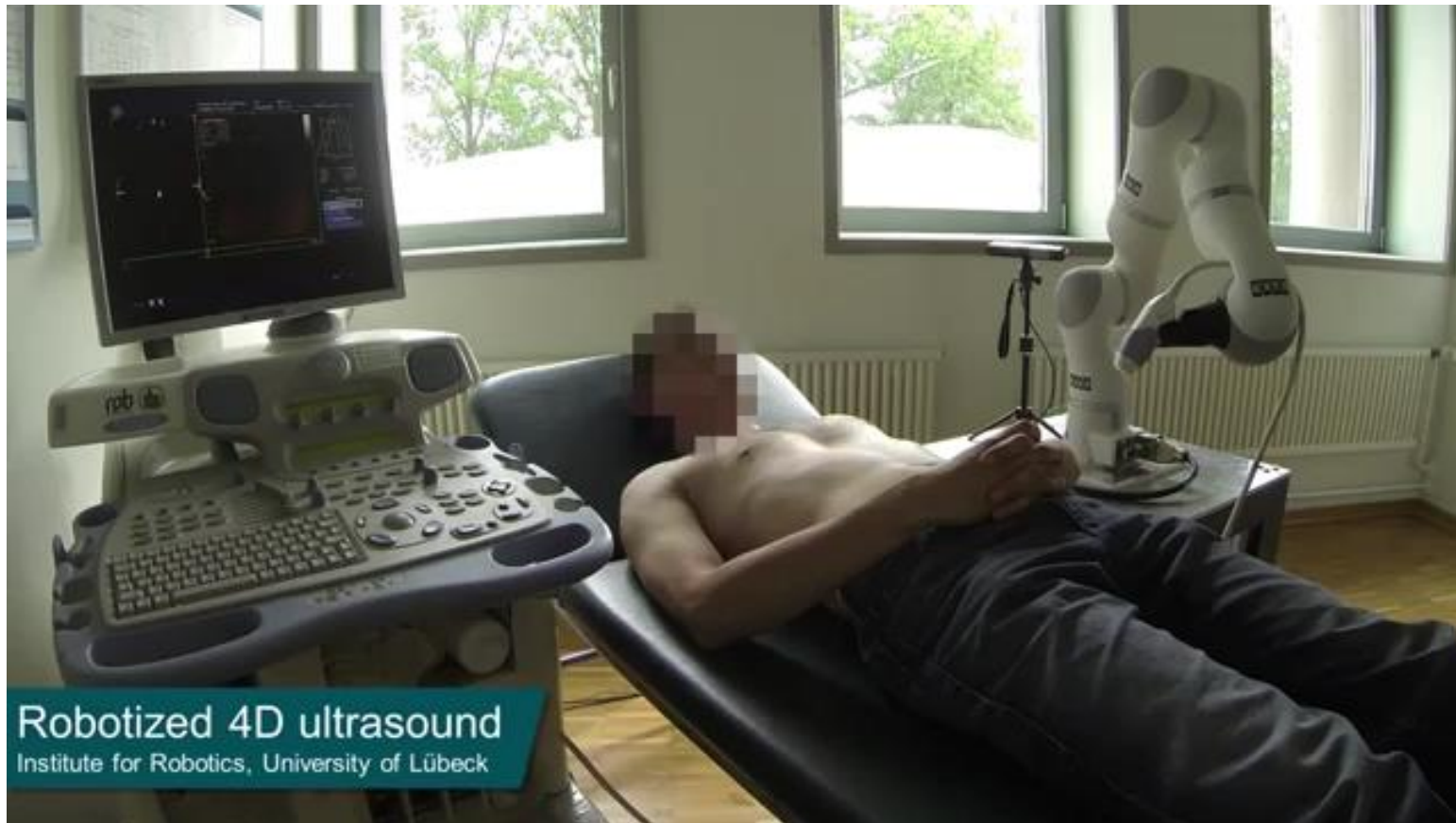
- ultrasound transducer mounted on a KUKA LBR robot
- image-based 3D ultrasound registration with a real-time servo-control scheme
- allows tracking a target anatomy, continuously updating the plan as the target moves
- needle guide for accurate manual insertion allows e.g. lumbar spine injections
- Research Group Prof. Dr. Nassir Navab: CAMPAR (Computer Aided Medical Procedures & Augmented Reality)
- **Authors:** O. Zettinig, B. Fuerst, R. Kojcev, M. Esposito, M. Salehi, W. Wein, J. Rackerseder, B. Frisch, N. Navab

Cooperative Robotic Gamma Imaging: Enhancing US-guided Needle Biopsy



- Gamma Camera mounted on a KUKA LBR robot
- Hand-held Ultrasound probe equipped with an optical marker
- A standard 2D camera mounted on the robot allows tracking the ultrasound probe
- Ultrasound Image and Gamma camera image are superimposed to distinguish between active and benign lymph nodes
- Research Group Prof. Dr. Nassir Navab: CAMPAR (Computer Aided Medical Procedures & Augmented Reality)
- **Authors:** M. Esposito, B. Busam, C. Hengersperger, J. Rackerseder, A. Lu, N. Navab, B. Frisch

Research – University of Lübeck

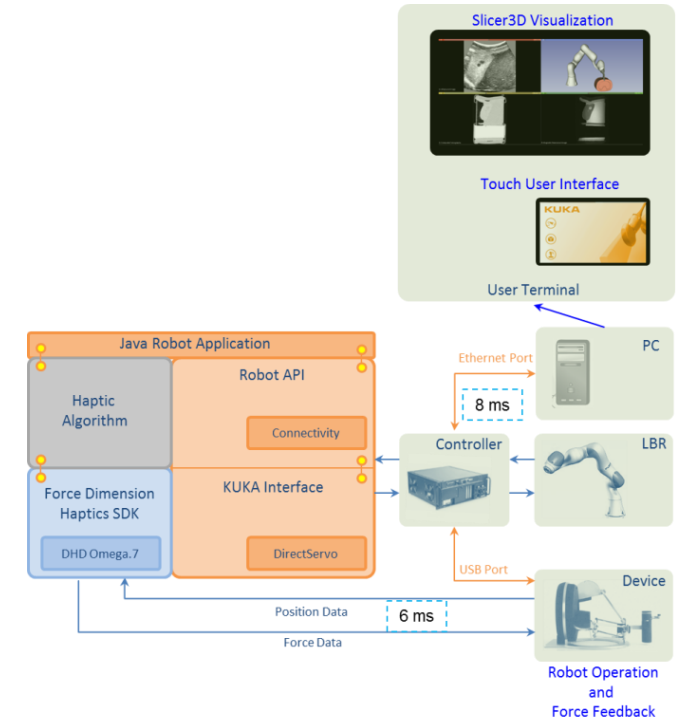
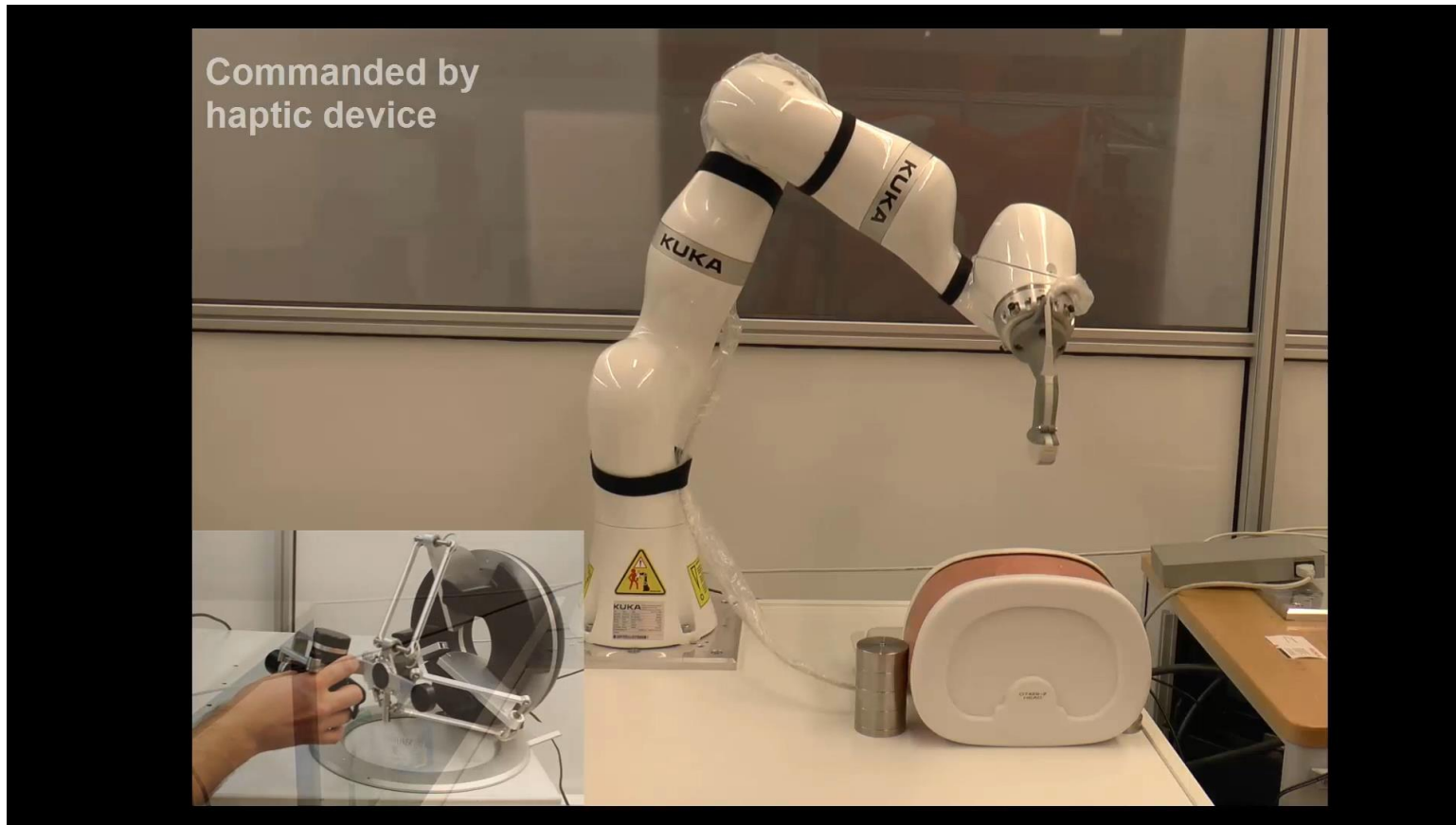


Robotized 4D Ultrasound

Institute for Robotics and Cognitive Systemes



Telemanipulation for Ultrasound with Haptic Feedback



- Ultrasound probe coupled to LBR iiwa
- Telemanipulation with haptic feedback using a ForceDimension controller
- Algorithms for collision detection using Fuzzy Logic
- **Author:** Ricardo Perez

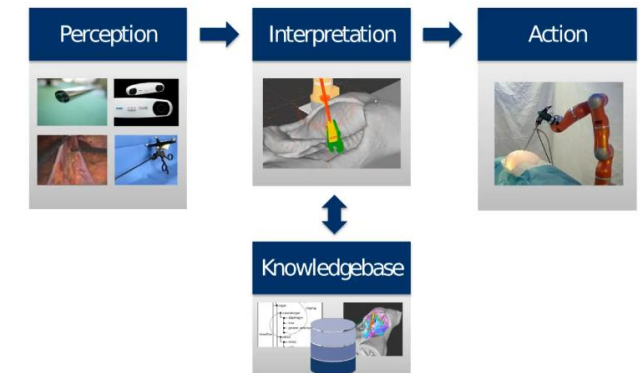
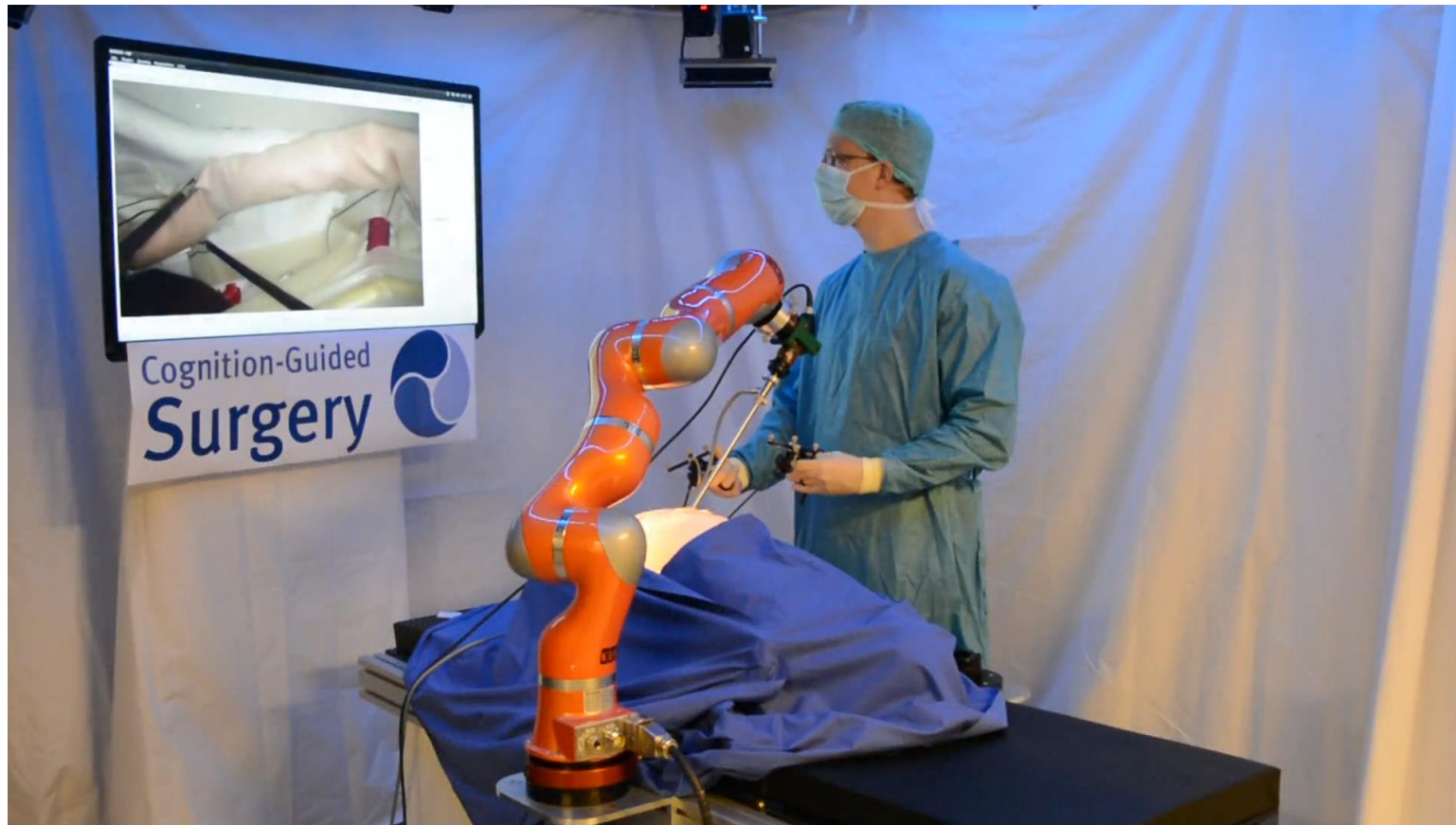


MURAB: MRI and Ultrasound Robotic Assisted Biopsy



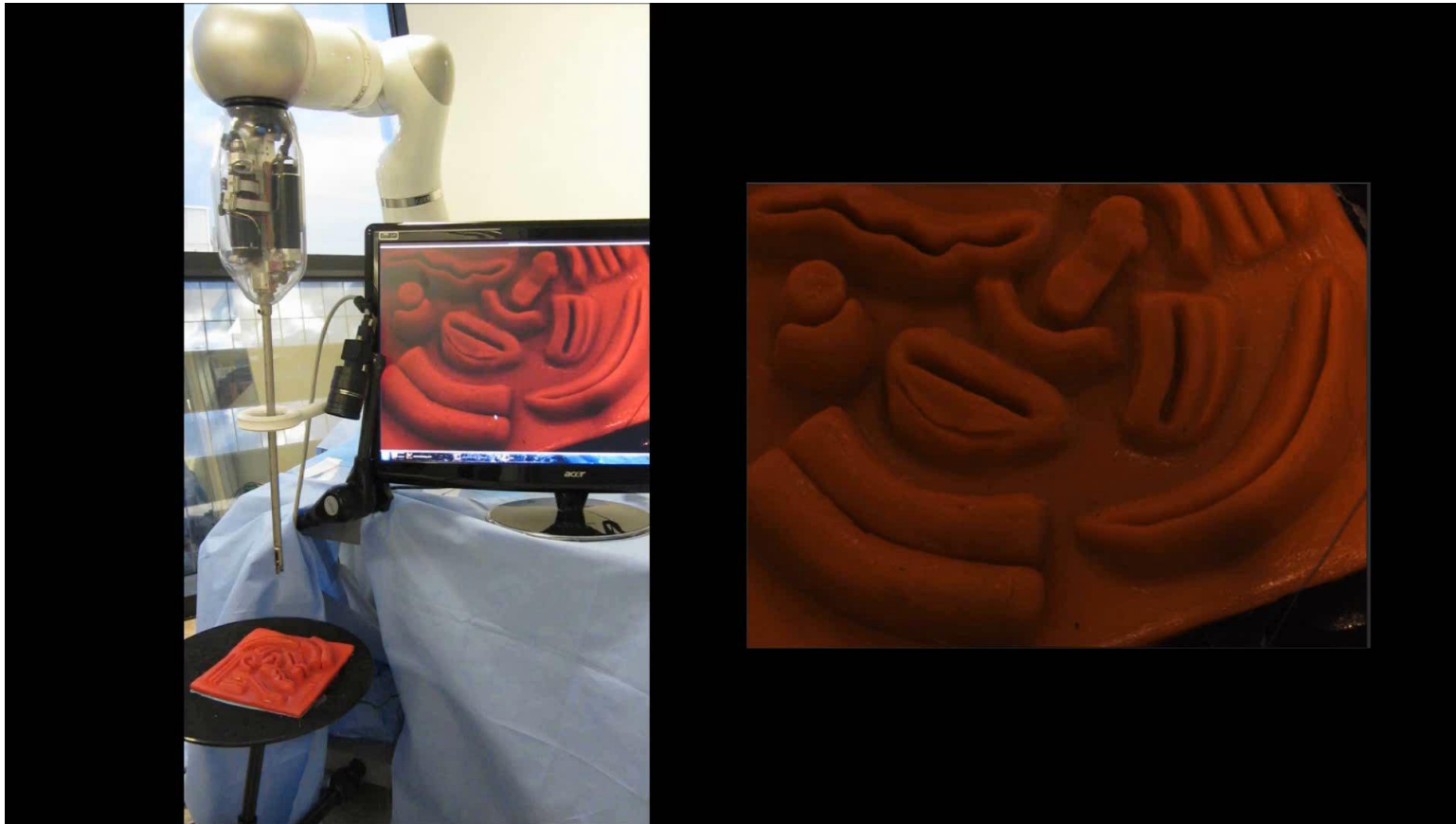
- **Enabling US-guided biopsies of lesions that are visible on US images, but with higher accuracy (without previous MR imaging)**
- **Enabling US-guided biopsies of lesions that are not visible on US images**
- **Patient discomfort reduction** because US-guided biopsies can be smaller
- **Efficiency increase for the patient** by preventing return visits (which also reduces discomfort)
- **Efficiency increase for the doctor** by speeding up current (MR-guided) biopsies

Cognition-Guided Camera Control



- Part of the research project SFB 125 – Cognition guided Surgery
- Workflow analysis of several procedures fed into the machine learning system
- Automatic camera guidance modelled on knowledge base, can be performed with different robotic architectures
- **Authors:** A. Bihlmaier, M. Wagner, S. Bodenstedt, P. Mietkowski, S. Speidel, B. Müller-Stich, H. Wörn, H. Kenngott

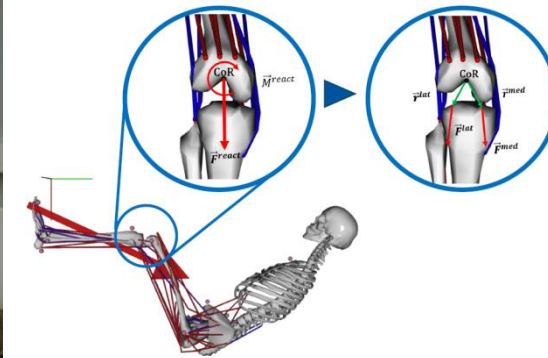
STAR System (Smart Tissue Anastomosis Robot)



Laparoscopic	daVinci	STAR
9 minutes	5 minutes	1 minute

- An automatic suturing tool was motorized and attached to the KUKA LBR robot
- Using the camera image, suture points are defined and the tissue is tracked
- The automatic movement is being calculated and executed, closing the anastomosis

HaiLeg: High articulated intelligent Leg A robotized sensitive leg press for Analysis and Rehab



- 1) **Data analysis**
→ Motion capture data for simulation
- 2) **Complex model of lower limb**
- Calculation of joint torques and forces
- Calculation of muscle forces
- 3) **Biomechanic model of the knee**
- Modeling contact geometry

Integrator: BEC , Research Partner: German Sport University Cologne/ Institut for Biomechanics & orthopedics (IBO)



Thank you!

Richard Davis

Account Manager, Medical Robotics

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