Performance of a Service Robot as Surgical Assistant

Sebastian Klug, David Putzer, Michael Nogler
Experimental Orthopedics
Innsbruck Medical University

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Outline

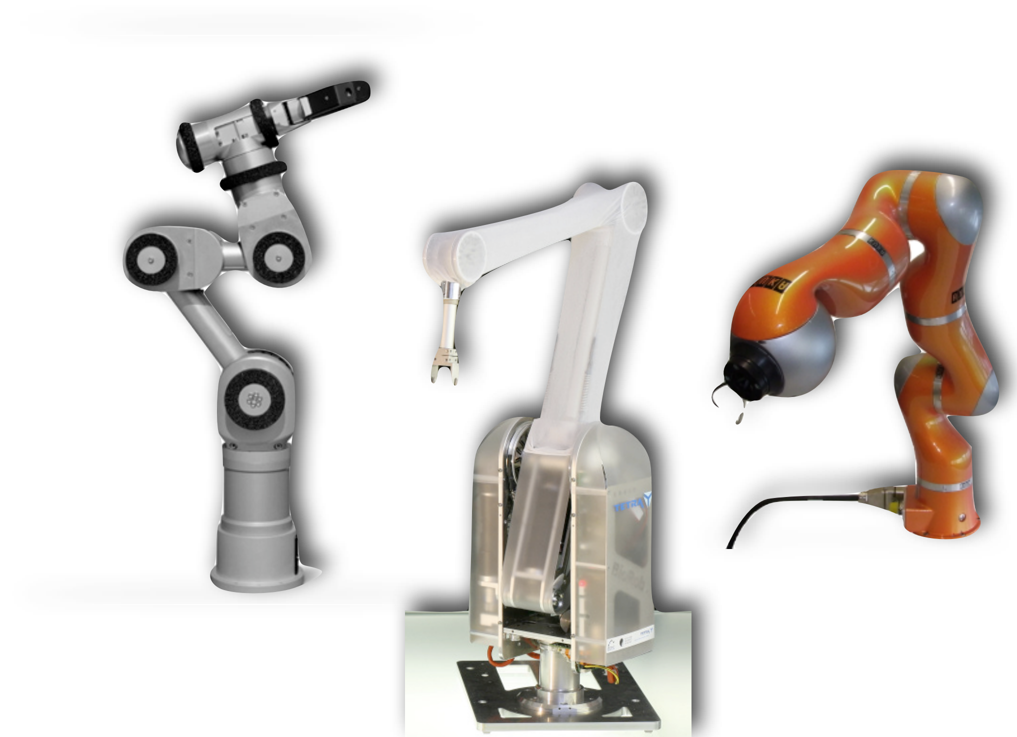
- Requirements
  - Service Robotics
  - Orthopaedic Surgery
- Our robotic system
- Experimental Results

SERVICE ROBOTICS

Industrial robots

- high accuracy
- heavy structure
- stiff actuation
- used strictly separated from human users

Service robots



- direct interaction with human user possible
- light weight design
- compliant actuation / mechanic

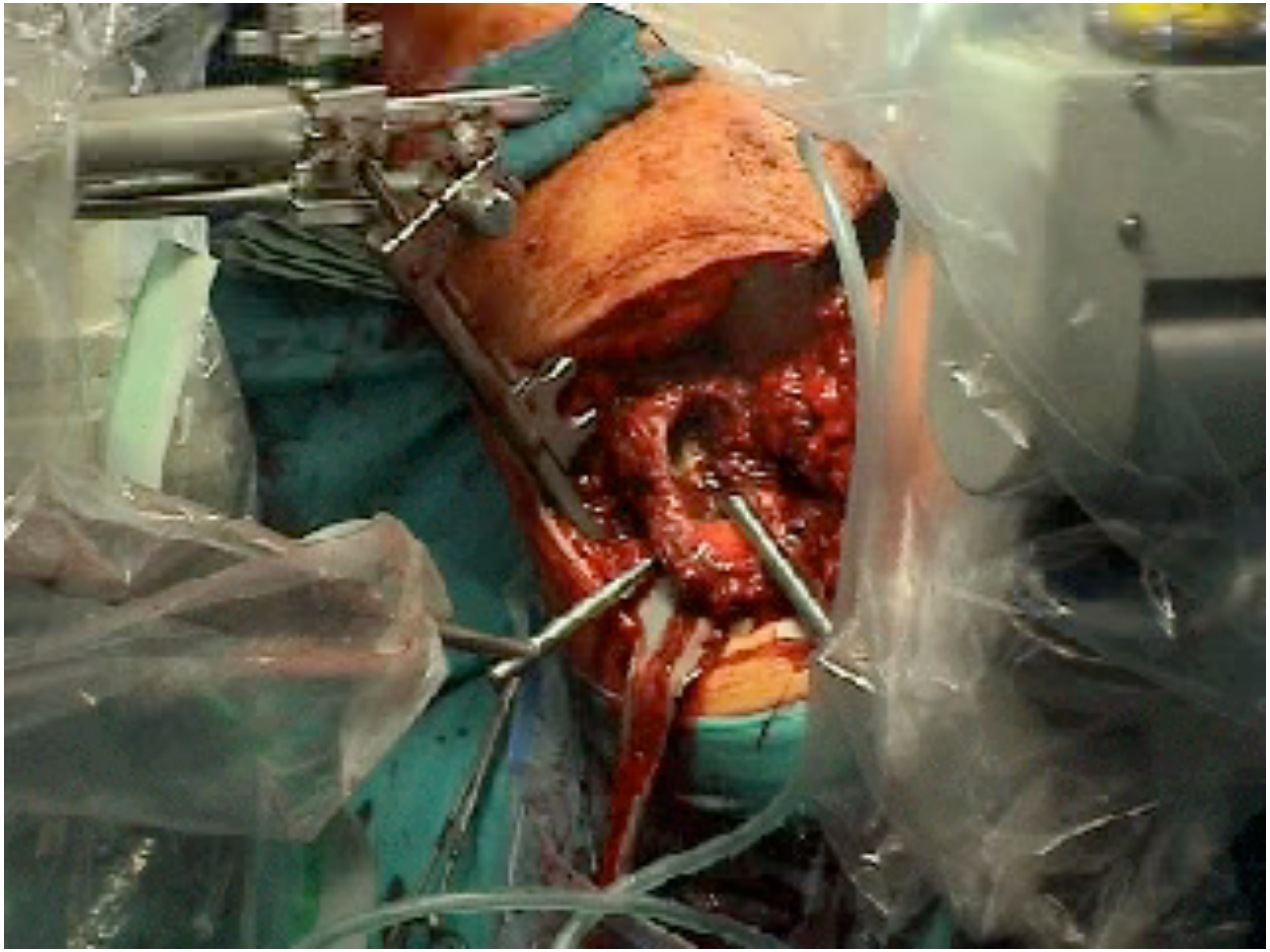
SERVICE ROBOTICS

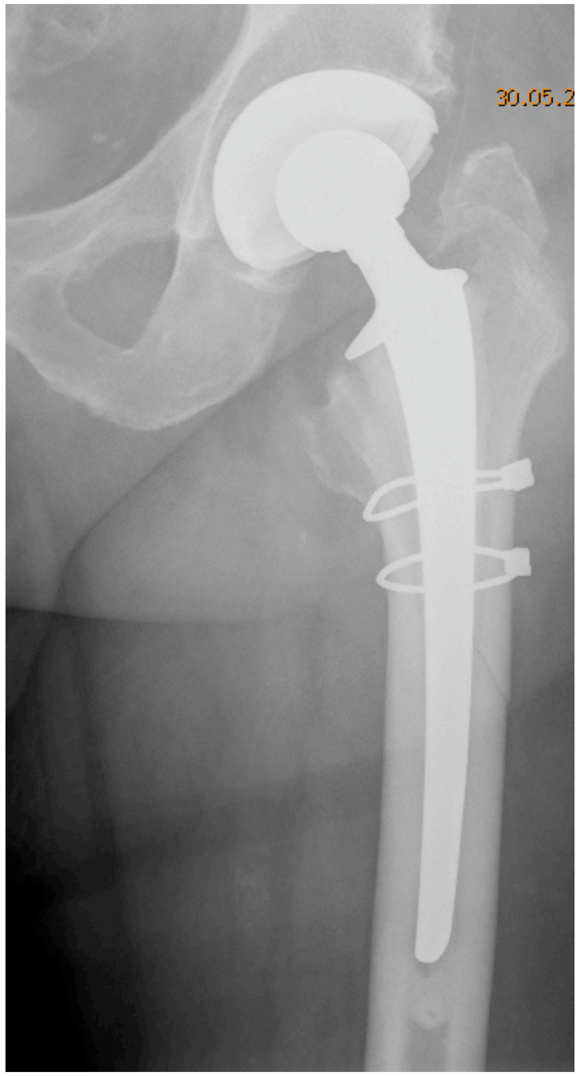
Safety
Flexibility
Usability
Human-like performance

Service robots

- direct interaction with human user possible
- light weight design
- compliant actuation / mechanic

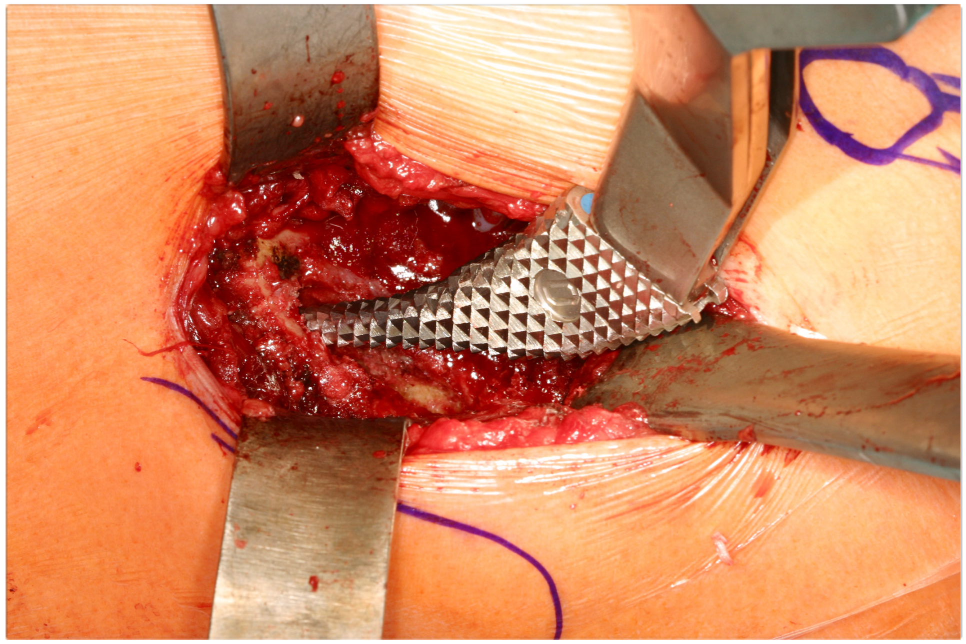
Robotic surgery - RoboDoc

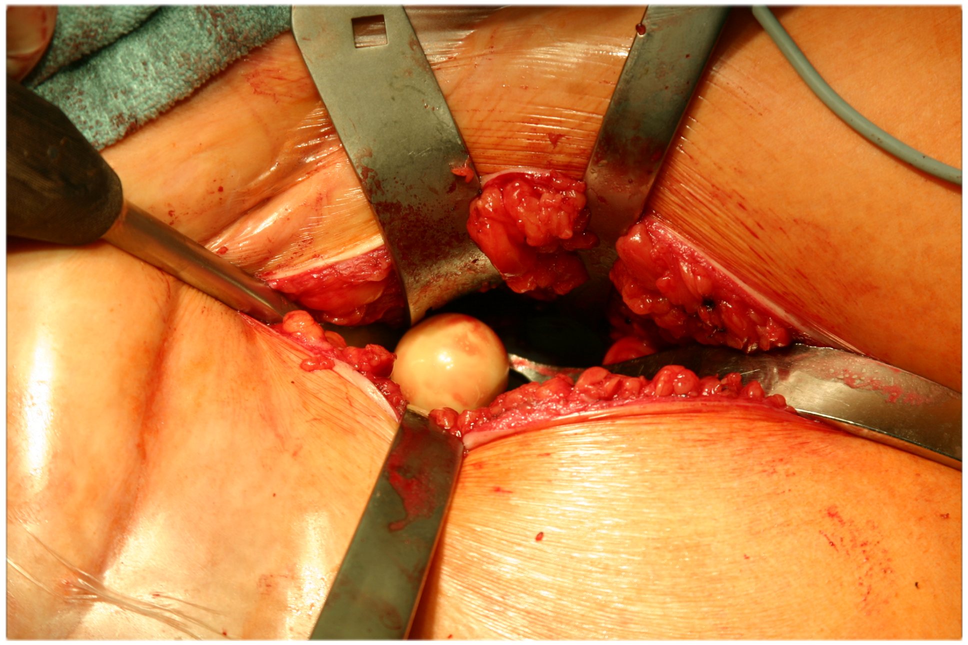




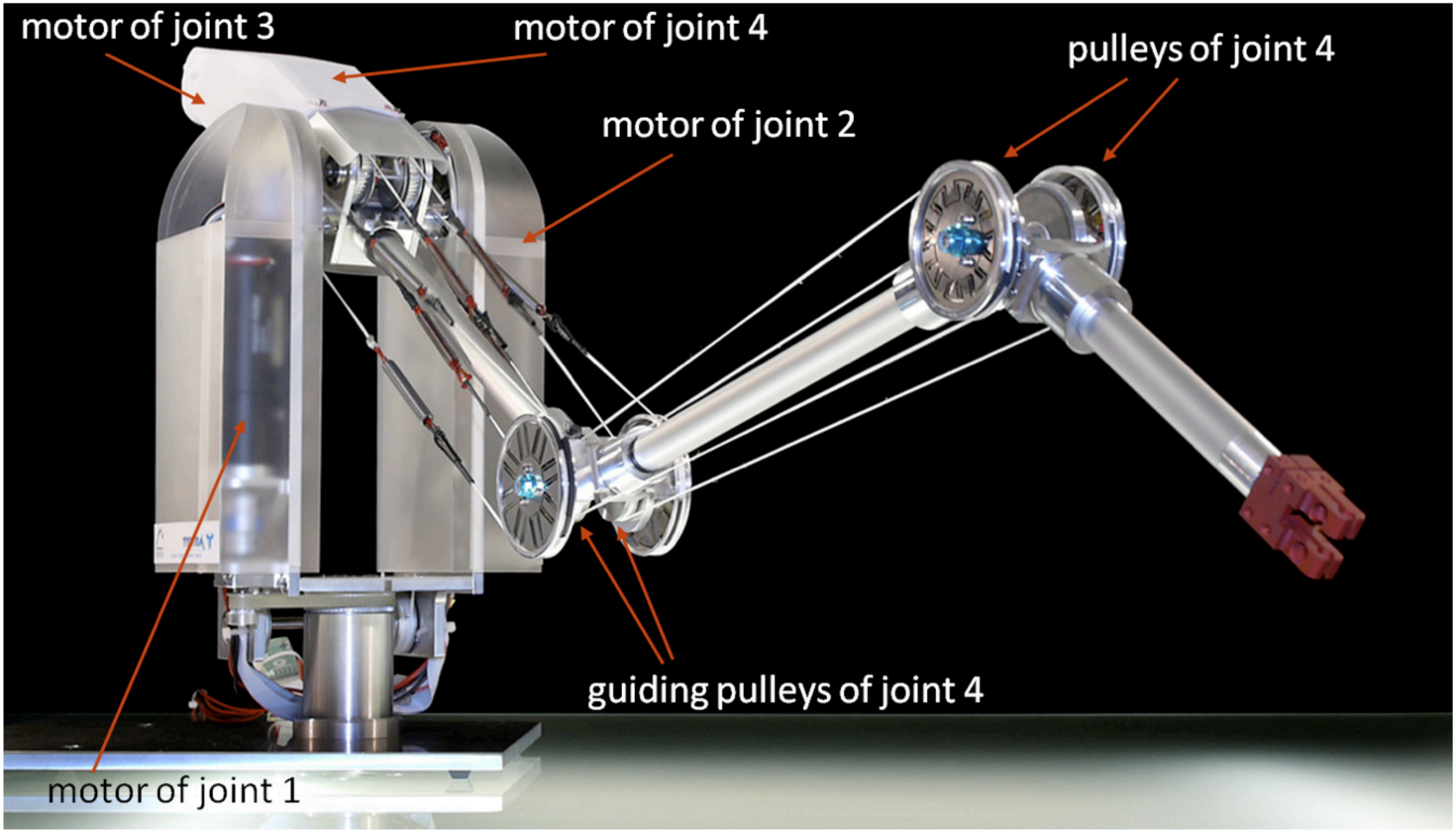
ORTHOPEDIC SURGERY

Minimal invasive surgery





General design



Motion dynamics

Dynamic of a stiff robot

(e.g. Spong 2006)

$$\ddot{\boldsymbol{q}} = M(\boldsymbol{q})^{-1}\left[\boldsymbol{\tau}_m - C(\boldsymbol{q},\dot{\boldsymbol{q}})\,\dot{\boldsymbol{q}} - G(\boldsymbol{q})\right]$$

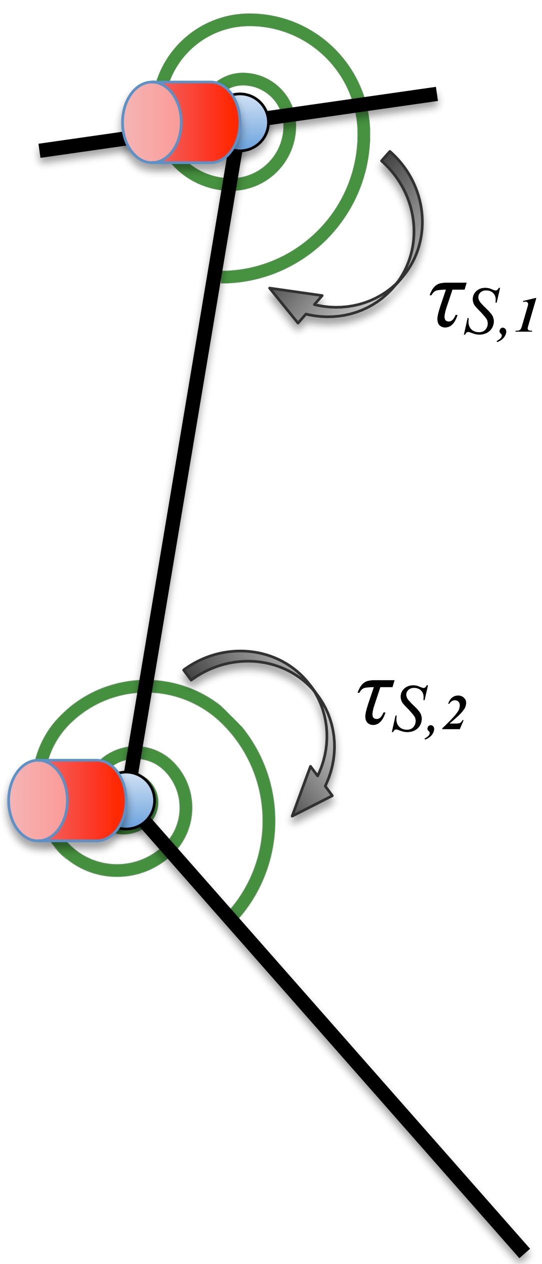
Extension for an elastic robot

(DeLuca & Tomei 1996)

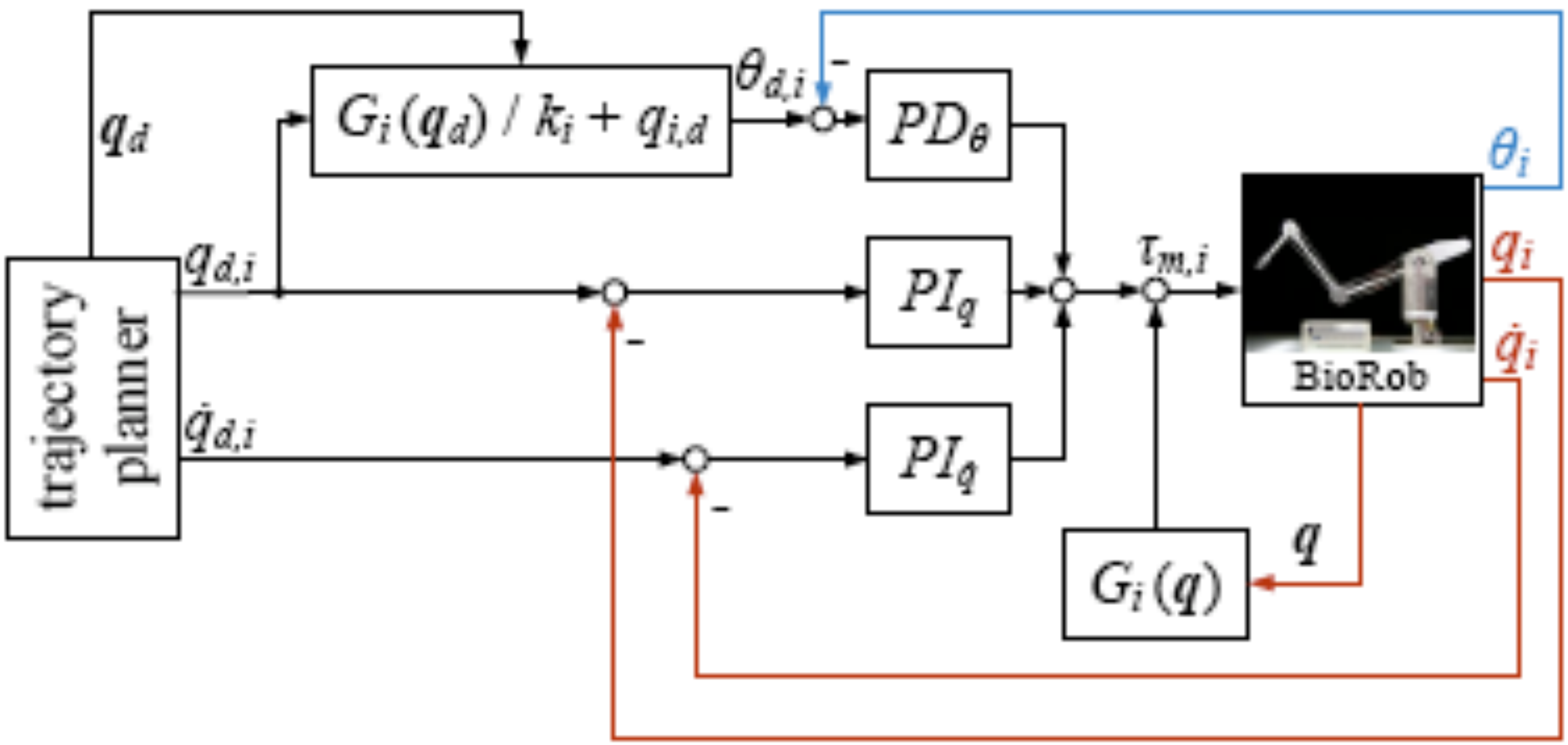
$$\ddot{\boldsymbol{q}} = M(\boldsymbol{q})^{-1}\left[\boldsymbol{\tau}_S - C(\boldsymbol{q},\dot{\boldsymbol{q}})\,\dot{\boldsymbol{q}} - G(\boldsymbol{q})\right]$$

$$\ddot{\boldsymbol{\theta}} = J_M{}^{-1}\left[\boldsymbol{\tau}_m - \boldsymbol{\tau}_S\right]$$

$$\boldsymbol{\tau}_S = E_S\,(\boldsymbol{\theta} - \boldsymbol{q})$$

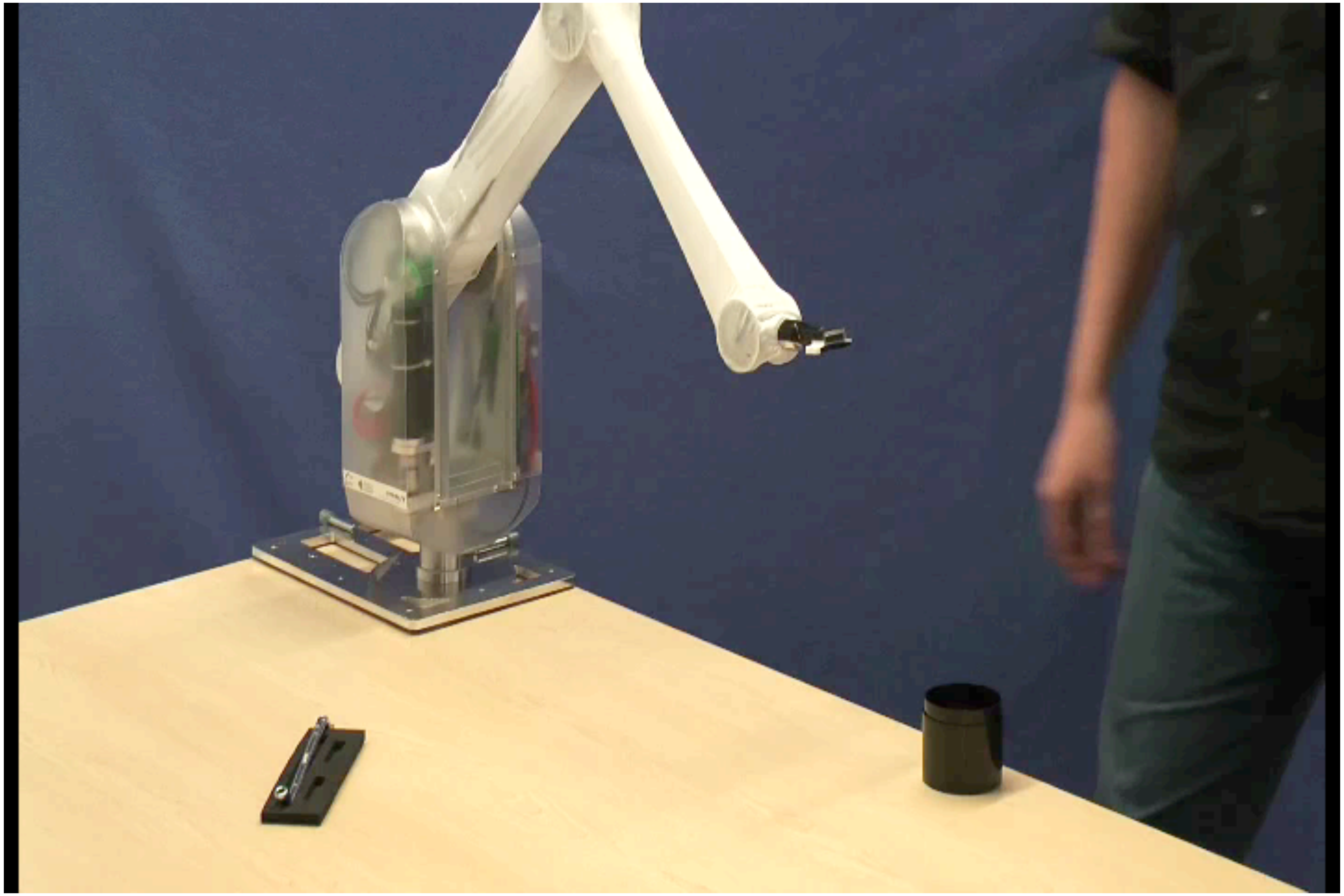


CONTROLLER STRUCTURE

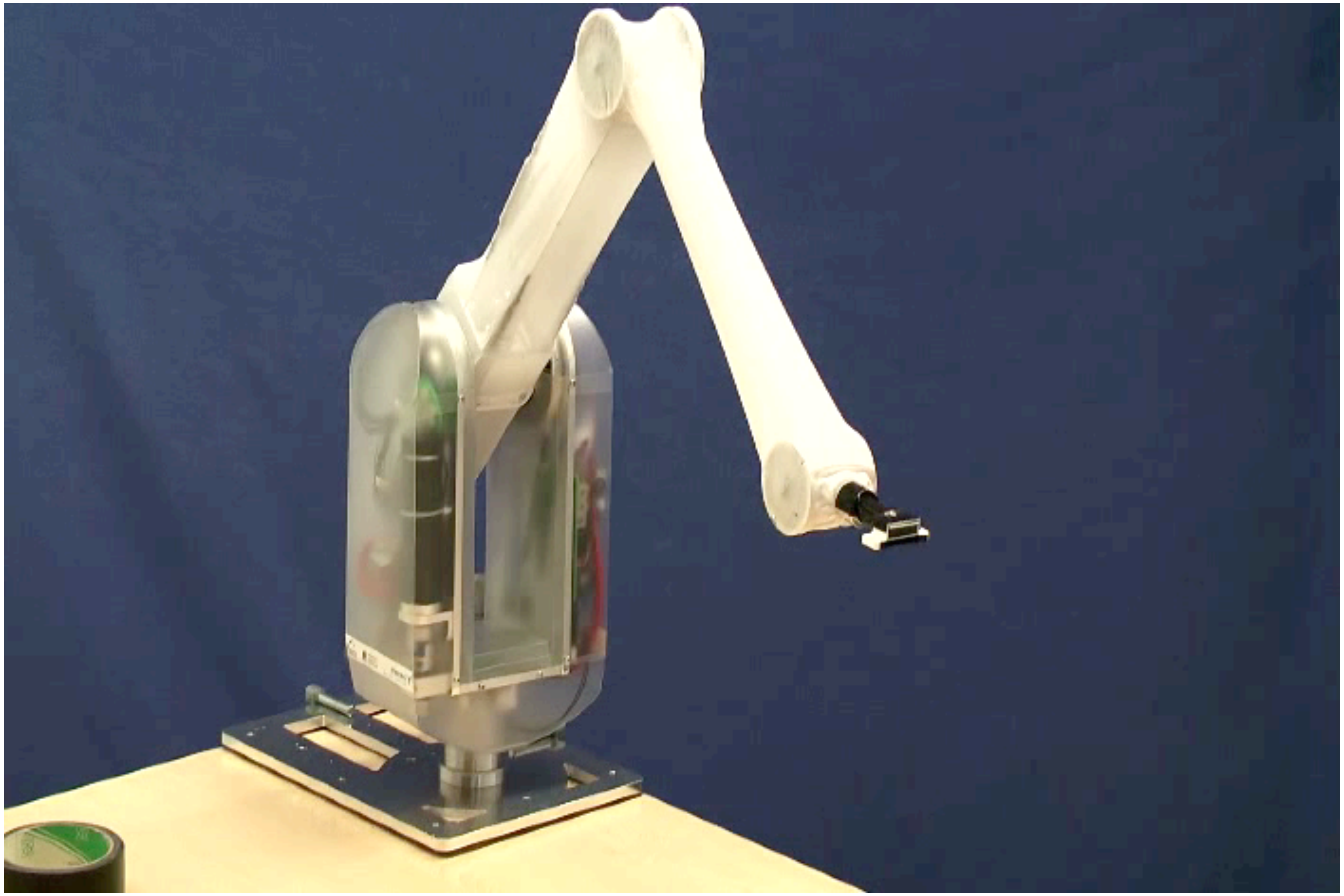


Experiments

Manual teach-in



Playback



Experiments

Retraction of soft tissue

EXPERIMENTS

Stable to external forces

Conclusion & Outlook

- The general applicability of a service robot in medical applications were shown
- In a simulated surgical setup better results were shown according stability and repeatability compared with human assistants

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- Analysing the need and the possible tasks for a robotic assistive system
- Developing of a gripper system, combining with surgical navigation system
- Further assistive applications (e.g. hands-on milling)

Thank you for your attention

Questions?