Performance of a Service Robot as Surgical Assistant

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• Requirements
  • Service Robotics
  • Orthopaedic Surgery

• Our robotic system

• Experimental Results
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

Service robots

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Safety
Flexibility
Usability
Human-like performance

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Orthopedic Surgery

Robotic surgery - RoboDoc
Orthopedic Surgery

Minimal invasive surgery
General design

- Motor of joint 1
- Motor of joint 2
- Motor of joint 3
- Motor of joint 4
- Pulleys of joint 4
- Guiding pulleys of joint 4
Motion dynamics

**Dynamic of a stiff robot**
(e.g. Spong 2006)

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

**Extension for an elastic robot**
(DeLuca & Tomei 1996)

\[ \ddot{q} = M(q)^{-1} \left[ \tau_S - C(q, \dot{q}) \dot{q} - G(q) \right] \]
\[ \ddot{\theta} = J_M^{-1} \left[ \tau_m - \tau_S \right] \]
\[ \tau_S = E_S (\theta - q) \]
Controller Structure

\[ q_d \xrightarrow{G_i(q_d) / k_i + q_{i,d}} \theta_{d,i} \xrightarrow{PD_\theta} \theta_i \]

\[ q_{d,i} \xrightarrow{q_i} \dot{q}_{d,i} \xrightarrow{PI_q} \dot{\tau}_{m,i} \xrightarrow{G_i(q)} q \]

\[ \tau_{m,i} \xrightarrow{PI_q} \dot{q}_i \]

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Manual teach-in
Playback
Experiments

Retraction of soft tissue
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

- 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?