

Telerobotics and Haptics

C. Preusche

Summary

Telerobotics and Haptics

Actual and Future Research Questions and Applications

Carsten Preusche

Institute of Robotics and Mechatronics German Aerospace Center (DLR)

IST'06 - Advanced Haptics Workshop



Outline

Telerobotics and Haptics

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Summary

Introduction

- What is Telerobotics?
- Haptics in Telerobotics
- Telepresence

Research Issues

- Systems
 - Telerobots
 - Haptic Interfaces
- Control
 - Supervisory Control
 - Bilateral Control
- **Applications**
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Tele-Robotics means to overcome a **barrier** between a human and a remote environment



remote



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What is Telerobotics?

Summary

Tele-Robotics means to overcome a **barrier** between a human and a remote environment







Distance











remote



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Tele-**Robotics** means that the human controls a robot to change a remote environment





Distance



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remote



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- Scene is mainly perceived by 3D Vision
- visual modality is dominant
- → no haptics
- but: Material/Surface characteristics missing
- Haptic Exploration is needed

- Manipulation require a close human-environment interaction
- Force-Feedback is evident
- to Telerobot and Human Controller



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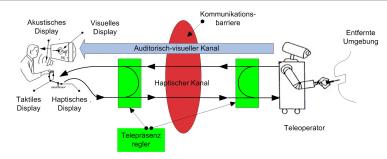


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Haptics in Telerobotics

Summary



- Manipulation require a close human-environment interaction
- Force-Feedback is evident
- to Telerobot and Human Controller



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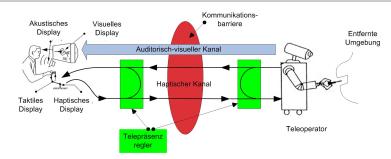
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Manipulation

- Manipulation require a close human-environment interaction
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Focus on haptics on Telerobotics





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Telepresence – Transparency

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Telepresence The human operator feel present at the remote location with all his/her sensor-actor modalities.

Transparency The human operator cannot distinguish between operating in the local or distant environment.



Telepresence – Transparency

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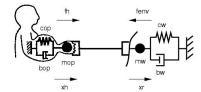
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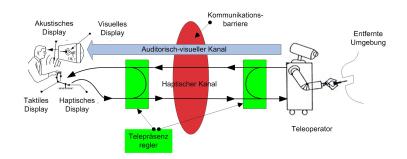


Open Research Issues

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Research Issues



- Telerobots
- Haptic Interfaces
- Control (with Time-Delay)



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We need Humanoid Telerobots

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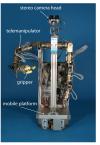
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Shape of Telerobot is important for Telepresence



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Asimo by Honda



DLR - Justin



Haptic Interfaces

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Haptic Interfaces

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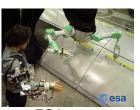
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Integration of kinesthetic and tactile feedback



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Control Strategies

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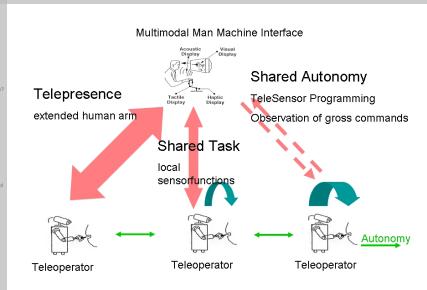
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Supervisory Control

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Shared Task

- direct 3D Control
- Overlay of Sensor values





Supervisory Control

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Shared Task

- direct 3D Control
- Overlay of Sensor values



Shared Autonomy

- intuitive VRProgramming
- Pre-simulation / TaskObservation





Supervisory Control

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Summary

Shared Task

- direct 3D Control
- Overlay of Sensor values



Shared Autonomy

- intuitive VRProgramming
- Pre-simulation / Task Observation



Haptics from world-model enhances presence and performance



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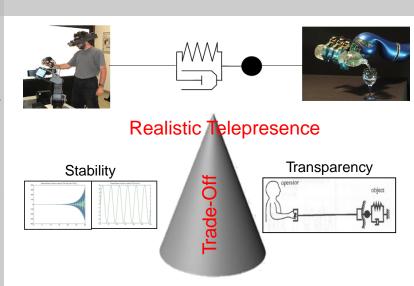
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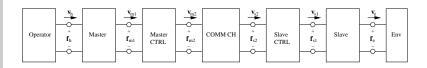


Passivity

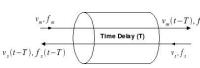
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- network description for stability/passivity analysis
- whole system is passive, if all individual blocks are passive
- main problem-source of activity: communication delay



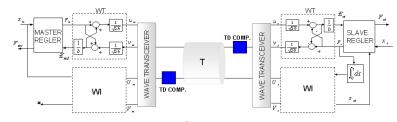


New Concepts

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Improved Wave-Variables Scheme (Robotik 2004, Artigas, Preusche et.al.)



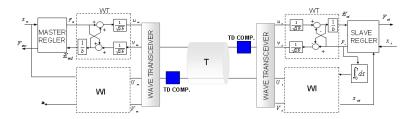
New Concepts

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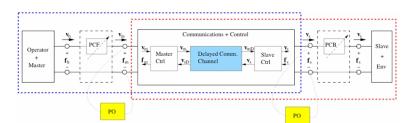
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Improved Wave-Variables Scheme (Robotik 2004, Artigas, Preusche et.al.)



Time Domain Passivity Control Scheme (IROS 2006, Artigas, Preusche et.al.)



Stability versus Passivity

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Analysis of stable regions for a haptic rendering system IROS 2006: Hulin, Preusche et.al.



Stability versus Passivity

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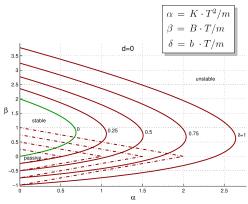
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Summary

Analysis of stable regions for a haptic rendering system IROS 2006: Hulin, Preusche et.al.

Passivity is more conservative than stability

→ less transparency





Applications

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Applications

Summary

Some Applications are presented from the following fields

- Rescue and Danger
- Surgery
- Maintenance and Manufacturing
- Space



Applications Rescue and Danger

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Applications



Rescue Support Dragon (Japan)





Telerob - tEODor



Applications Surgery

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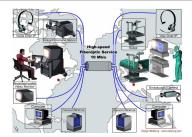
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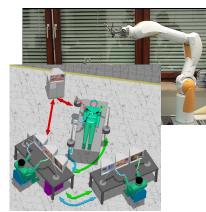
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Operation Lindberg – The first transcontinental telerobotic surgery (2001)



DLR - TeleSurgery Vision



Applications Maintenance / Manufacturing

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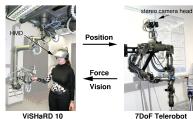
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Applications

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Microassembly (TUM)



master slave

TeleMaintenance (TUM)





Applications Space

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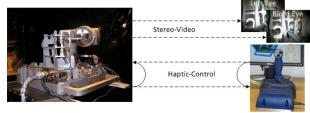


Opportunity (NASA)



Satellite Repair (DLR)

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Applications

- Need for human-like Teleoperators in terms of shape and sensor-actor abilities
- Integration of haptic stimuli (tactile, kinesthetic, proprioceptive) into one handheld device
- Reliable, fast and high-bandwidth communication networks



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- Overcome limitation of passivity towards evaluation of stability
- Measurement of transparency as index psychophysical versus engineering indices
- Adaption of bilateral control to unreliable networks e.g. Internet



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- There is an increasing interest in telerobotic systems
- The barrier of **danger** delivers a killing application



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■ There is an increasing interest in telerobotic systems

■ The barrier of danger delivers a killing application



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Haptic Interfaces

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Thank you for your attention!