Tutorial: Control Issues in Haptic Teleoperation

Organizer: The Technical Committee on Telerobotics
Angelika Peer, Cristian Secchi, Katsunari Sato, Cenk Cavusoglu

ABSTRACT
Telerobotics is one of the most traditional fields of robotics and it played a crucial role in the history of robotics and of mankind, especially in the areas of space and underwater exploration and of remote material handling. On the other hand, teleoperation is still a very active research area and many problems are still open. In particular, the design of the control strategy for coupling local and remote site is of paramount importance for implementing telepresence, namely the feeling of being directly interacting with the remote environment.

The IEEE RAS Technical Committee on Telerobotics would like to propose a half-day tutorial for illustrating several successful control strategies for implementing high performance bilateral teleoperation systems.

1 ORGANIZERS
This tutorial is organized by the RAS Technical Committee on Telerobotics:

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2 LIST OF PRESENTERS

<table>
<thead>
<tr>
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<th>Affiliation</th>
<th>Status of confirmation</th>
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<tbody>
<tr>
<td>Sandra Hirche</td>
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<td>Korea University of Technology</td>
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3 LIST OF TOPICS

- Basic concepts in controlling haptic teleoperation systems
- Time-domain passivity approach for haptic teleoperation systems
- Model-mediated teleoperation
- Human-oriented Control for Networked Haptic Telepresence
4 MOTIVATION AND OBJECTIVES

The area of control of teleoperation systems is very active and many different control strategies have been proposed. The main objective of this tutorial is to concisely present the main issues in the control of a bilateral teleoperation system and to illustrate some of the most successful control strategies proposed in the last years. In particular, a short introductory lecture will provide some background on the control problems that arise in telerobotics. Once a common background has been established, the tutorial will show how to develop efficient controllers from three different points of view: passivity, model mediation and human-centred.

Passivity theory has been widely used for controlling teleoperation systems. It allows achieving a stale behaviour but, unfortunately, performance is quite low. Time domain passivity methods allow overcoming the weaknesses of standard passivity based control strategies and they allow obtaining both stability and high performance.

Standard bilateral control strategies use just force and position information for transmitting the motion of the user to the remote side and the force of the environment to the local side. Model mediated approaches aims at improving performance by transmitting model estimates of the evolution of the remote environment rather than just force and motion information. In this way, the remote environment can be haptically and graphically displayed to the user for providing an intuitive interface for controlling the slave side.

Humans play a crucial role in a teleoperation system and disregarding their presence when designing a control architecture can lead both to poor performance and to unnecessary complicated controllers. Human-oriented control strategies explicitly consider the human in the design of the control architecture and they allow providing to the user a good perception of the remote environment while keeping the complexity of the controller low enough.

We believe that the tutorial will give to newbies a sufficient background for understanding the main problems and the modern approaches to the control of teleoperation. On the other side, the tutorial will help researchers in telerobotics to have an overview on the most recent and exciting control strategies for bilateral teleoperation.

5 TENTATIVE SCHEDULE AND AGENDA

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<thead>
<tr>
<th>Time</th>
<th>Presenter</th>
<th>Title</th>
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<tr>
<td>14:00 – 14:30</td>
<td>Angelika Peer</td>
<td>Introduction to Telerobotics: Basic Concepts and Approaches</td>
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<tr>
<td>14:30 – 15:30</td>
<td>Jee-Hwan Ryu</td>
<td>Time-domain Passivity Approach and its Applications to Haptic and Telerobotic systems</td>
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<tr>
<td>16:00 – 17:00</td>
<td>Gunter Niemeyer</td>
<td>Model-mediated teleoperation - Moving beyond direct force feedback</td>
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<tr>
<td>17:00 – 18:00</td>
<td>Sandra Hirche</td>
<td>Human-oriented Control for Networked Haptic Telepresence</td>
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6 RELATION TO FORMER WORKSHOPS / TUTORIALS

This tutorial stays in close relation to several former activities of the Technical Committee on Telerobotics. This includes the workshop “New Vistas and Challenges in Telerobotics” held at ICRA 2008, the special session "Advanced teleoperation control architectures" at IROS 2010 and the Summerschool on Telerobotics 2010 held from July 26th-30th in Munich, Germany.