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assisted endoscopic surgery training; 3.1.1.1 Haptic perception in computer-assisted surgical training; 3.2 Haptic User Interface Architecture; 3.2.1 Force reflection in pitch, yaw and insertion; 3.2.2 Force reflection in roll and gripping; 3.3 Analysis of the Haptic Interface; 3.3.1 Sensitivity; 3.3.2 Workspace; 3.3.2.1 Optimization for control accuracy; 3.3.3 Force reaction capability; 3.4 Concluding Remarks; 4. Unilateral Teleoperation Control; 4.1 Introduction; 4.1.1 Direct inverse dynamics control
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4.2 PHANToM Inverse Dynamics Identification; 4.3 Adaptive Inverse Dynamics Trajectory Control of the PHANToM; 5. Bilateral Teleoperation Control; 5.1 Introduction; 5.2 Stability and Transparency in Haptic Teleoperation; 5.2.1 2-channel architectures; 5.2.1.1 Position Error Based (PEB); 5.2.1.2 Direct Force Reaction (DFR); 5.2.2 4-channel architecture; 5.2.2.1 Scattering theory and absolute stability; 5.2.2.2 Stability and performance robustness; 5.2.2.3 3-channel case; 5.3 Haptic Teleoperation Experiments; 5.3.1 Experimental setup
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5.3.3 Observation of hand forces; 5.3.4 Observer and controller gains; 5.3.5 Soft-tissue palpation tests; 5.4 Concluding Remarks; 6. Substitution for Haptic Feedback; 6.1 Introduction; 6.2 Graphical Substitution for Haptic Feedback; 6.2.1 Case study: Lump localization task; 6.2.1.1 Experiment design; 6.2.1.2 Results; 6.2.1.3 Discussion; 6.3 Multi-Modal Contact Cues; 6.3.1 Case study: Tissue stiffness discrimination Task; 6.3.1.1 Experiment Design; 6.3.1.2 Results; 6.3.1.3 Discussion; 6.4 Concluding Remarks; 7. Bilateral Teleoperation Control Under Time Delay
7.1 Introduction

Sommario/riassunto

An important obstacle in Minimally Invasive Surgery (MIS) is the significant degradation of haptic feedback (sensation of touch) to the surgeon about surgical instrument's interaction with tissue. This monograph is concerned with devices and methods required for incorporating haptic feedback in master-slave robotic MIS systems. In terms of devices, novel mechanisms are designed including a surgical end-effector (slave) with full force sensing capabilities and a surgeon-robot interface (master) with full force feedback capabilities. Using the master-slave system, various haptic teleoperation c
