# Control Strategies for Robots in Contact

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In the field of robotics, there is a growing need to provide robots with the ability to interact with complex and unstructured environments. Operations in such environments pose significant challenges in terms of sensing, planning, and control. In particular, it is critical to design control algorithms that account for the dynamics of the robot and environment at multiple contacts. The work in this thesis focuses on the development of a control framework that addresses these issues. The approaches are based on the operational space control framework and estimation methods. By accounting for the dynamics of the robot and environment, modular and systematic methods are developed for robots interacting with the environment at multiple locations. The proposed force control approach demonstrates high performance in the presence of uncertainties. Building on this basic capability, new control algorithms have been developed for haptic teleoperation, multi-contact interaction with the environment, and whole body motion of non-fixed based robots. These control strategies have been experimentally validated through simulations and implementations on physical robots. The results demonstrate the effectiveness of the new control structure and its robustness to uncertainties. The contact control strategies presented in this thesis are expected to contribute to the needs in advanced controller design for humanoid and other complex robots interacting with their environments.

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