Industrial robots typically require detailed programming and carefully configured work cells to perform well. The large engineering effort implicates high cost and long preparation time, and this is the major obstruction when mediating tasks to robots. The research in this thesis therefore aims to make robot programming faster and more accessible. Methods that allow for programmers to mediate and modify tasks by means of demonstration are presented. Further, robots' abilities to replan with respect to unforeseen changes in their surroundings are enhanced, thus lowering the effort needed for work-cell configuration.

We first consider adjustment of robot movements generated by dynamical movement primitives (DMPs). DMPs are motion-control laws with emphasis on easy modification. For instance, goal configuration and time scale for a certain movement can be updated through one parameter each, commonly without further consideration. In this research, these capabilities are extended to support modifications based on demonstrations through physical human–robot interaction. Further, the motion-control laws are extended to support online replanning for overcoming unforeseen movement deviations. Subsequently, a method that enables robots to recognize contact force/torque transients acting on the end-effector, without using a force/torque sensor, is proposed. This is achieved using machine learning. The robot is first exposed to examples of force/torque transients. Based on these data, a recurrent neural network (RNN) is trained to recognize such transients. The functionality is used to automatically determine when a robotic subtask is finished, to proceed to the next subtask at the right time. Finally, a control algorithm for teleoperation with force feedback is developed. It allows for an operator to demonstrate movement and forces remotely. One robot arm is moved directly through physical contact with the operator, and a distant robot arm moves accordingly. Interaction forces are reflected to each side of the interface. Each of the methods presented in this thesis is implemented in a realtime application and verified experimentally on an industrial robot.