

Dissertation title:

**Roboter manipulationsfähigkeiten zur Automatisierung von
Instandhaltungsaufgaben**

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In current production systems, plant availability and product quality play an important role, especially concerning economic objectives. In order to be able to consider these factors, production systems are subject to regular maintenance. Whereas there are already methods for inspection tasks allowing automated fault-diagnosis, there are no methods available to solve the following service or repair task. For the possibility of automated maintenance and repair, strategies are investigated which permit a robot-based automation, thus support the human worker and, in the long run, enhance the attractiveness of production in high-wage countries.

For the ability of robotic systems to solve such complex tasks autonomously under realistic conditions, special skills for planning and control of robotic manipulations are developed. A particular emphasis in developing these methods is placed on time-efficient planning algorithms as well as to incorporate environmental uncertainties between existing a priori and sensor data.

For task planning a method is proposed, which generates, based on CAD and visual sensor data the required manipulations in the form of symbolic primitives. Through a novel sampling-based approach an extremely time-efficient computation of disassembly spaces is feasible. In order to enable a targeted acquisition of relevant sensor data, an algorithm is presented that allows by means of task-dependent metrics, the combination of map exploration and object recognition in a suitable sensor pose. For path planning, for the execution of the individual manipulation tasks, state-of-the-art algorithms are used. But, a pre-processing strategy is introduced, which allows a considerable reduction of the planning space based on an adaptive step size control, which achieves a significantly shorter planning period and a higher success rate in finding a possible solution. The description generated from the planning is further translated in an executable robot program. For this purpose, the decomposition into elementary robot control instructions based on a general decomposition rule is permitted, which are executed via proprioceptive or exteroceptive controllers in a task-oriented way.

The developed manipulation capabilities are integrated into a robot control architecture and are validated experimentally on a demonstrator system, using representative real-world applications.