SDMBot

Software-based Process Empowerment for Industrial Robots

In industry, robots are being used more and more frequently thanks to their high flexibility. This flexibility, however, is often limited by cumbersome programming processes. Robots then have to be manually guided through all movements, and this ties up time and resources. Instead, it should be possible to tell the robots roughly what task to perform and then let them plan for themselves how to do it.

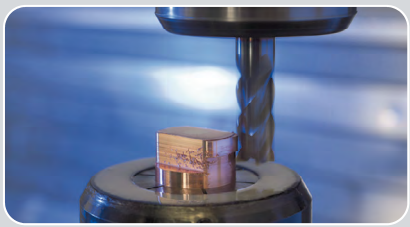
In the area of manipulation, there has already been great progress based on approaches such as reinforcement learning and model predictive control (MPC). In the area of manufacturing, however, these systems lag behind. This is primarily due to the fact that the robot simulations used for this empowerment cannot simulate the processes. For example, in welding, the quality of the seam is not considered, and in milling, the process force is ignored.

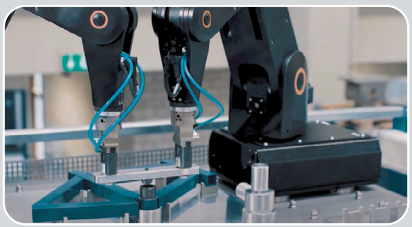
Process-aware Simulations in Robotics

Only by considering the interactions between the process and the robot can the necessary precision and the high flexibility required for the demands of shorter product life cycles and highly volatile markets be achieved. For robot software empowerment, holistic simulation solutions thus are needed. The relevant simulation tools allow the entire manufacturing process to be modeled and simulated in a virtual environment. This includes the robots, the tools, and the materials used in the manufacturing process. The virtual environment then allows testing of different scenarios and analyzing of the effect of changes to the processes and robots. Thus, with the help of common planning algorithms, specific given manufacturing tasks can be planned autonomously.

Solution of the KIT

At wbk Institute of Production Science, open source software tools were developed that enable precisely this kind of simulation. For this purpose, robot simulations were extended by process models of e.g. milling, welding, or painting.





Adding Material
- Welding
- Gluing
- 3D Printing
- Coating
- Etc…

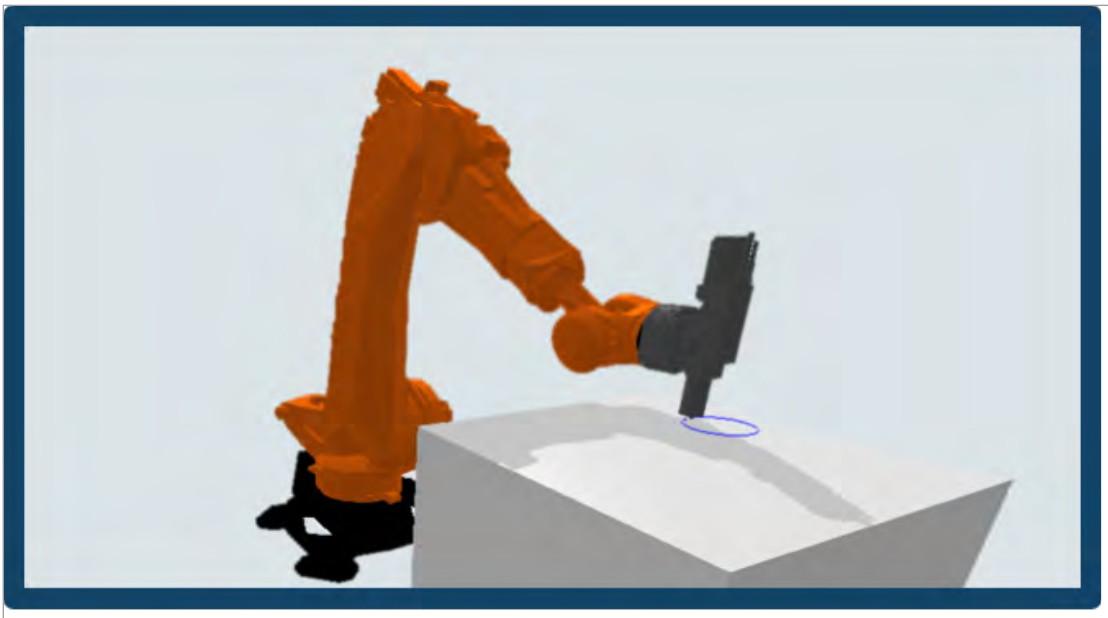
Removing Material
- Milling
- Drilling
- Cutting
- Etc …

Moving Material
- Gripping
- Holding
- Transport
- Etc…

Simulatable processes
(Photos: KIT, wbk Institute of Production Science)

An example application of these tools is presented at Hannover Messe. A welding process is pre-simulated before a robot follows the final trajectory. Production planning is carried out via virtual reality (VR) and enables potential industrial users to experience the robot from the operator's perspective and directly influence it.

This enables testing and programming of the robot in a realistic environment without the need for actual physical contact. Through simulation, problems and weak points can be identified and corrected in advance, which contributes to a better quality of the final process.



Robotic manufacturing system with digital image (Photos: wbk Institute of Production Science)

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