Success Story
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AEDA
Advanced Engineering Design Automation
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Programme line: K-Projects
COMET subproject, duration and type of project:
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Optimized Motion Planning for a Materials Handling Robot Realizing Space-Efficient Feedbacks in the Material Flow of Production Plants

Panel-sizing plants are employed to cut panels of different materials to specific sizes and to then sort and stack them. In order to keep waste to a minimum also in the context of customer-specific production, cutting plans become more complex, which results in that they can only efficiently be produced on plants with feedbacks in their material flow. Within digital product development of complex, technical systems, the here described work achieved the development and virtual commissioning of a material handling robot, which keeps spatial requirements of plants to a minimum and thereto considers constantly changing spatial limitations as input.

Goal, Challenges, and Results

The objective of the project was to develop an algorithm for motion planning for a materials handling robot (Fig. 1), to integrate it into the control system of the plant, and to test and validate it by virtual commissioning.

Fig. 1: The materials handling robot
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The main challenge concerning the algorithm was that the spatial limitations vary for each piece of material which has to be transported and that they are partially very tight with the result that there is little space left to route. Other challenges to be tackled were at which level of the central hierarchical control system of the plant and in which form the algorithm should be integrated and, subsequently, how to set up a test bed.

The outcomes of the project comprise a prototypical implementation of an algorithm for motion planning, its integration at PLC (programmable logic controller) level, virtual commissioning of the materials handling robot, and the testing of the algorithm on a real plant.

Development of a Prototype and Virtual Commissioning

The task of the new materials handling robot for panel-sizing plants is to transport a panel from a starting point to an end point by picking it up with the aid of a suction unit and then pulling it over a brush table horizontally, while the robot can additionally rotate around the vertical axis during that movement, if necessary. For illustration purposes, the mentioned components and their main constraints are depicted below in Fig. 2.

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The panels (red) are rectangular and must not exit a given area (dashed red polygon). The mechanical system of the robot (blue) is also represented as a rectangle, which must stay inside its limitations (dashed blue polygon), too.

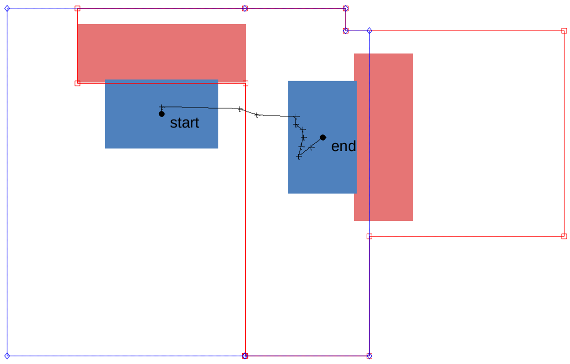

Fig. 2: Motion planning example

The motion planning algorithm was developed using MATLAB®. In order to incorporate the algorithm into the control system, a C/C++ DLL is automatically generated from the MATLAB® code. The DLL is integrated at the PLC level of the central hierarchical control system of the plant through an interface for calling high level language programs from the control program which allows a higher degree of complexity of the algorithm than directly programming in PLC code. A reason for connecting the motion planning algorithm to the PLC and not to the process control is that the PLC handles the exceptions. The PLC passes the output data of the motion planning on to the motion controller which uses them.

Before testing the motion planning algorithm on a real plant, virtual commissioning of the materials handling robot was performed (see Fig. 3).

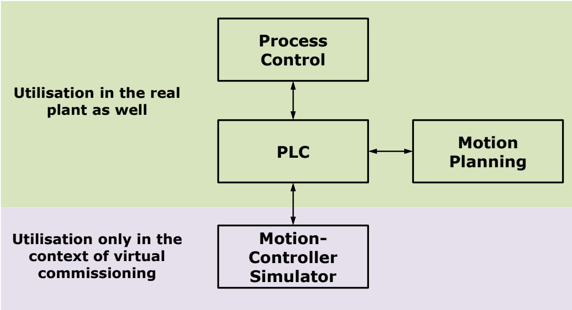

Fig. 3: Virtual commissioning of the materials handling robot

Specifically for this purpose, a simulator of the motion controller is employed whereas the process control and the PLC together with the motion planning are used as part of the real-world plant later on. The benefits of the test bed for motion planning are the improved quality of the algorithm and reduced commissioning time and costs of the plant.

Impact and Effects

The trend towards customer-specific production lead to the development of panel-sizing plants with feedbacks in their material flow. Together with V-Research, first, the simulation-based, reliable and precise calculation of key performance indicators was developed and, second, the emulation-based control design which ensures deadlock-free operation. Third, the development and optimization of the control of the materials handling robot which keeps the spatial requirements as to realizing feedbacks in the material flow to a minimum was achieved. All of these prototype developments significantly contributed to the development of panel-sizing plants for customer-specific production.

Contact and information

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