Implementation of Control Software for the Automated Manufacturing of SmartCatheters

Degree programme: Master of Science in Engineering | Specialisation: Electrical Engineering
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The manufacturing of smart catheters requires a high amount of manual labor. This amount can be reduced with a new catheter structure, based on a LCP bonded to a TPU substrate. Due to this improvement, the manufacturing process complexity gets broken down and allows automation. This automation is implemented with a system, developed at the BFH, and a programmable logic controller combined with an industrial-grade human-machine interface from B&R Industrial Automation GmbH.

Motivation

The manufacturing of complex catheters, which implement various sensing features, is a tedious process and requires a high amount of manual labor. Unfortunately, the state-of-the-art structure of such a catheter does not allow to reduce the ratio of manual labor during the manufacturing process. So at the Institute for Human Centered Engineering (HuCE) of the Bern University of Applied Sciences (BFH) a new approach, concerning the structure of such a catheter, was pursued. By bonding a liquid crystal polymer (LCP) onto a substrate consisting of thermoplastic polyurethane elastomer (TPU) the possibility for new applications was given.

Methods

This new structure further allows automation of the manufacturing process. By embedding the electrical circuitry and the wiring into the LCP the complexity of the catheter manufacturing can be shifted to the elaborated LCP manufacturing process. Therefore the manufacturing of the catheter can be reduced to the thermobonding process. This thermobonding process and the corresponding mechanical manipulation of the LCP and the TPU is implemented with the smartCath system. The smartCath system consists of a stepper motor-driven manufacturing machine combined with a dedicated programmable logic controller (PLC) and an industrial-grade human-machine interface (HMI) from B&R Industrial Automation GmbH.

Results

Software

The software controlling the smartCath system is implemented in C++ and conforms with the object-oriented programming (OOP) paradigms. It implements a high abstraction from the B&R software framework and therefore provides a high degree of portability. Further, it combines industrial control software concepts with object-oriented design patterns.

Digital Twin

Due to the short project timeline, a hardware/software co-design took place, to lower the risks of the commissioning near the end of the project, a digital twin (see figure 1) was implemented. This digital twin allows integration testing in the early phase of the project and reduces critical failures in the later project stages. By using Matlab/Simulink in combination with the Simscape toolbox, which is a resource already available resources at the BFH, and the Automation Studio MAT target from B&R a short implementation duration could be achieved.

Documentation

To ensure the successful continuation of the software project after the Master's thesis also the documentation needed to be considered. Therefore the source code documentation was implemented with a GitLab continuous integration (CI) and continuous delivery (CD) (CI/CD) pipeline generating Doxygen source code documentation, to make it accessible to the whole project team it is hosted on GitLab Pages. With a GitLab Wiki also the usage of the software is documented and can be reproduced.

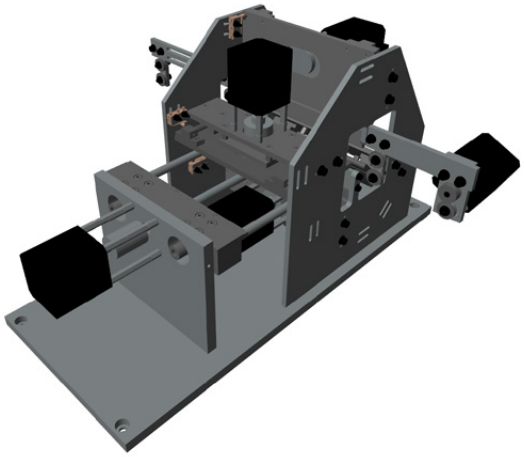

Figure 1: Digital Twin implemented in Matlab / Simulink with Simscape Multibody

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