Master's Thesis:

Design and Implementation of a Real-World Scenario for Physical Human Robot Interaction in Aircraft Construction

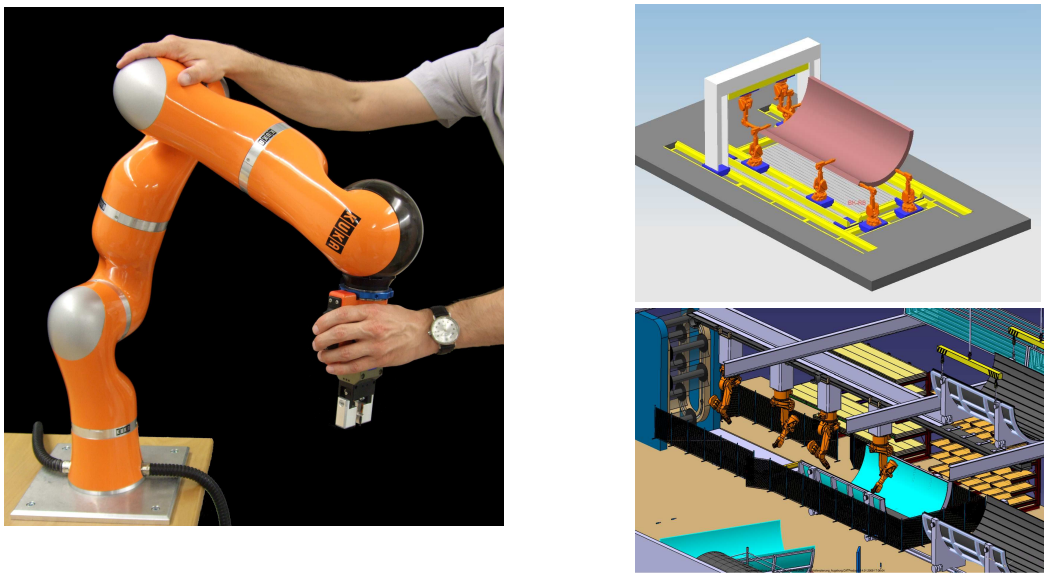

Figure 1: The new KUKA Lightweight Robot is designed for direct physical interaction with humans (left). Automated assembly with industrial robots in aircraft construction (right). The new case study developed together with the DLR ZLP will be the topic of this thesis and is one of the first examples where human and robot are sought to work closely together in a real-world use-case.

Recently, first robots have gained capabilities in both sensing and actuation, which enable operation in the proximity of humans, and even direct physical interaction is possible without suffering from loss in speed and payload. The DLR Lightweight Robot III (DLR-LWRIII), which technology is currently transferred to the robot manufacturer KUKA Roboter GmbH is such a device. The result of this collaboration is the KUKA Lightweight Robot (KUKA LWR), see Fig. 1 (left). The robots have a load-to-weight-ratio of 1 and are equipped with a joint torque sensor in each of their seven joints. This key technology makes it possible to realize various features that are crucial for direct interaction with humans. Impedance control and collision detection with adequate reaction are powerful key components for realizing "soft and safe" robotics. Furthermore, we have developed complex behavior patterns, which enable the robot to adequately react to sensory input, making it a powerful tool for processes that require the combination of both, human and robot capabilities in a closely cooperative fashion.

In this thesis a safe interaction concept for a real-world case study in aircraft construction, the design and implementation of novel interaction control schemes for this, and its prototypical implementation shall be carried out. The project is a collaboration between DLR's Institute of Robotics and Mechatronics and the Center for Lightweight Production Technology (ZLP). The given task is that human and robot (LWR-III) cooperatively assemble CFK structures in an airplane construction setting. In contrast to the fully automated setup depicted in Fig. 1 (right) this task cannot be fully automated. In the contrary, it crucially needs human expertise for successful completion. To achieve this, the robot has to directly support the human during folding large scale CFK structures, so they can be vacuum glued afterwards. During the entire process both are frequently in physical contact and thus, a major requirement is to understand how a robot should behave in order to **safely and intuitive** interact with the human and how to respond to disturbances along the process. For this, novel control strategies need to be designed and, together with the developed interaction scheme, integrated into the overall task.

Expected work steps

- Literature review

- Understanding of the LWR-III and its novel human-friendly control schemes
- Development of the appropriate interaction concept
- Identification and design of missing control and interaction algorithms that are necessary for the application
- Implementation of the case study in a realistic setup

Prerequesites

- Knowledge in MATLAB/Simulink
- Knowledge in robot control/nonlinear control
- Ability to work well structured and organized
- Creativity

Contact

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