Steps toward collaborative X-Ray tube assembly

Degree programme: BSc in Electrical Engineering and Information Technology
Specialisation: Automation, Control and Robotics
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Collaborative robots find more and more applications in industry for automating various tasks ranging from palletizing to quality inspection as well as assembly processes. Although it is easy to program them for specific tasks, making them flexible and suited to dynamic and changing conditions is still an ongoing challenge. This bachelor's thesis explores the principles of a collaborative and modular skills-based system for X-ray tubes assembly.

Introduction

Robots are a well-established tool for all kind of repetitive manipulation and handling tasks. Because of their standardized form factor and programming possibilities, they can be deployed with predictable costs and with moderate effort. For more elaborate tasks or tasks involving human intervention, on the other hand, deployment tends to be less straightforward. Here, we consider the assembly of X-ray tubes, where model variance is high and the assembled parts range from tiny to heavy. Hence, this is an ideal example of an assembly, where human intervention may be necessary to finish the task and the robot will need to be programmed to react to the human.

Objectives

To prepare the robot for showing reactive behaviour, it shall be programmed with a Skill based approach. For this purpose, a possible assembly sequence for a robot is created. Rigging and gripping strategies are established, and robot movements are developed to allow for the joining steps. Once a program is ready, which shows the ability of the robot to perform the assembly task, it can be used as a proof of concept and further features added. This is in line with modern agile development paradigms. Among the features to be added is the Skill based structure: the assembly sequence is structured so that single steps may be called individually by some artificial intelligence algorithm and allow reactive behaviour. Furthermore, image processing needs to be added such that the robot can actually identify missing and already assembled parts and show reactive behaviour. Finally, the code shall be ported to some hardware independent platform like ROS (robot operating system).

Results

The whole assembly process has been analysed and steps, which show potential to be profitably carried out by the robot, have been identified. For the identified steps, a program for a robot has been written in a conventional manner. On the other hand, every other step has been thoroughly examined and various solutions have been investigated. Regarding the vision of the system, two cameras were evaluated for localization of the different parts. The selected camera performs better with moving parts and has a faster capture time; this is important in collaborative scenarios to avoid misunderstandings between operator and robot. Image processing has been explored.

Outlook

For a fully seamless integration of the robot to manual additions during assembly, the gripping strategies need to be refined. Furthermore, the programmed sequences still need to be integrated in some framework for Skill-based robot operation, like SkiROS2. Finally, a redesign of the current X-Ray tube with robot-friendly features might be worthwhile.

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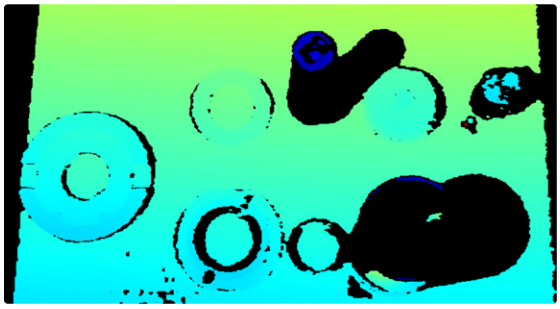
UR5e robot assembling a X-ray tube



MotionCam-3D vision