

Framework for Facilitating the Setting-up of Robot Systems for Handling Deformable Objects

This thesis presents a tool for reducing the integration cost of robotic automation systems in industry. The main focus is on tasks where a robot has to handle deformable objects, where deformable objects refer to objects that change shape as they are handled, e.g. sponges or meat pieces.

When designing robot systems, a huge challenge is the many days spent testing the systems before it is ready to be used. The approach presented here to speed up this process is to test the systems in simulation, rather than in the real world. A simulation is a virtual world in a computer, much like a video game, and if the robot solutions can be automatically tested here a lot of the man hours spent on testing in the real world can be reduced. Another advantage is that it can reduce the cost of hardware when building the test facilities since the test setup can be implemented in the virtual world purely from software. Besides allowing integrators to test in simulation, the overall tool also includes methods for simplifying the design process of the robot system. This is achieved through optimization, which tests many different robot systems in an automated way, in order to determine the most suitable robot system.

The long-term goal is a general purpose simulation and design tool to assist integrators in building robot systems and ensuring they work reliably. Ensuring a robot system works reliably can be a challenge, especially if it has to handle meat products. The problem with meat is that the same type of product can vary a lot since the animals the meat comes from varies. Thus the simulation tool must test many different variations of the meat products to ensure the robot system work reliably.

Such a tool could greatly simplify integration of robot systems, and thus make robot systems available for a larger market. Simplicity and speed of integration are especially important for small and medium-sized enterprises since such companies are unlikely to be able to support a team of experts to design automation solutions. Other challenges where such a tool could open new markets include automation of small batch production and production with short change over times. The main reason that these production types are difficult to automate is that the cost of integration is a big part of the overall production cost. So if the cost of integration can be reduced, it could make it financially sound to introduce automation in these domains.

In this thesis, the main focus has been the integration of robot systems for moving meat pieces. Two other robotic test cases have also been investigated within our general application of simulation and optimization. The first case is the design of robotic hands to better grasp solid objects. The other is the design of camera systems to determine where objects are placed in a scene. Having information of objects position in a scene can be important if a robot later is to pick up the objects.

The sum of the research contributions improves the toolbox for designing robot solutions for handling deformable objects. Especially in terms of making automation technology more accessible for the slaughterhouse industry at a lower cost.