Online Planning and Trajectory Generation for Industrial Bin-Picking Applications

Industrial production tasks are in recent decades being automated by robots. Practically every automobile driving on the road has parts built from automated production lines. Transporting objects between machines in these production lines comprise a significant part of them. When objects are arranged in bins or pallets, this task becomes easy, but often it is difficult or impossible to gain a high enough precision in structuring objects. To alleviate the constraints on packing objects, the application of bin-picking can be used. The common bin-picking setup includes an articulated robot arm, i.e. a series of rotary joints connecting a set of links, bins with randomly placed objects, and a scanning device to select individual objects in the bins, either placed stationary above the bins or directly in the end of the robot arm. The task of the application is then to sequentially pick objects from the bin, and place them with high precision at a specified position.

In this thesis, the area of moving objects around in a bin-picking cell is explored. The most important thing to consider is the movement speed. When the robot has picked an object, it should place it in its target position in a minimum of time. The second thing to consider is how to make the motion as predictable to an observer as possible. While it is perfectly possible to perform safe motions that are in no way predictable, it can alleviate the access of robots in a close corporation with nontechnical personnel. In this thesis previous knowledge of executed motions are used to obtain future motions. That is done by evaluating the executed motions and forcing future motions to act like these, depending on how useful they were. When defining usefulness as low execution times, this approach ends up with planning motions that are short and very similar.

Another important area of bin-picking is precision. To gain high precision when placing objects, these can be placed on an intermediary surface and re-picked with higher precision. Doing this, however, adds extra time to the application. To avoid the extra action of re-picking the objects, gaining extra precision while moving can be obtained by a sensor placed in the robot, but adds extra requirements on the motions, as these should be modifiable to accommodate the new correct information.

Setting up bin-picking applications is commonly done by trained expert personnel. That is rather expensive and time-consuming though, and automation of that task is therefore explored. The method investigated in this thesis considers the robots reachability and execution times when arranging the objects in the bin-picking scene.

The contributions in this thesis will hopefully motivate further research in both the areas of robot motion planning, but also robot workcell design methods.