Fraunhofer IPA

Fraunhofer Institute for Manufacturing Engineering and Automation IPA

Robot picking U-bolts out of a bin.

AI Picking

Status quo

Bin-picking has gained a foothold in some industrial applications in recent years. In this process, a robot picks up components from a bin and feeds them to a machine or sets them down in the correct position. However, this task is still so complex that bin-picking cannot always be used. This is due, for example, to short cycle times, complex part geometries or high part variance. Artificial intelligence can help to implement bin-picking even for demanding applications and thus extend its application.

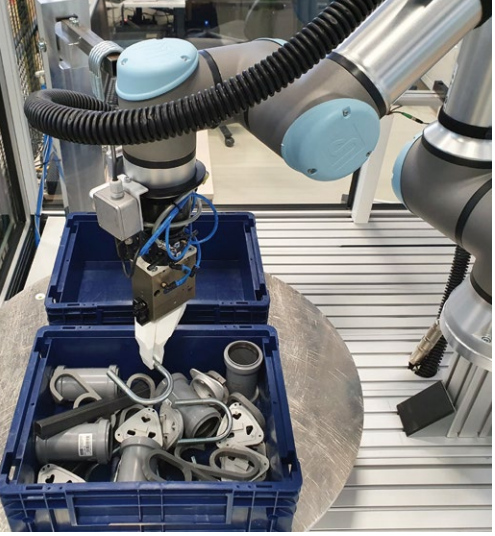
Our solution

To achieve these goals, we implement various technologies, from physics simulations to neural networks and reinforcement learning. In order to be able to place components in the desired position after they have been picked, they first have to be located. For this, we use a model-based approach, which is trained with CAD models of the components. The parts are located using a so-called **single-shot approach**, which determines the position of all detectable components within 20 milliseconds. The best gripping points, how well they can be gripped, and the anticipated placement accuracy are taken into account at the same time.

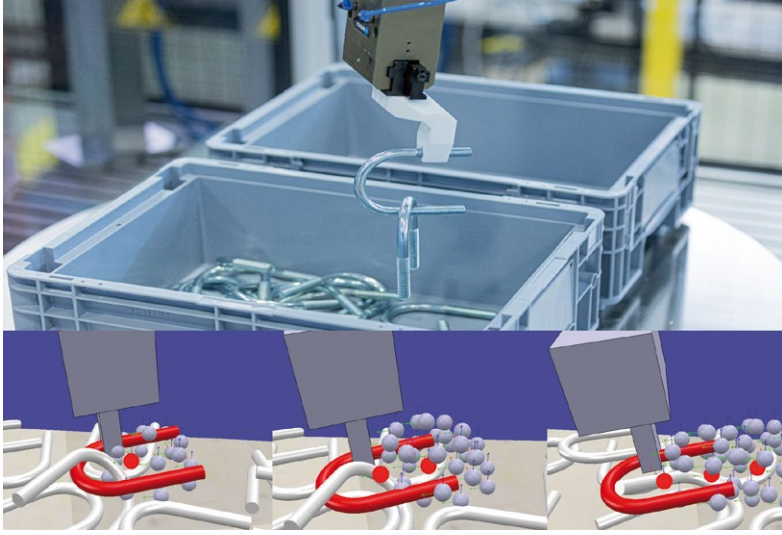
Simple commissioning thanks to simulation and artificial intelligence

Unlike conventional approaches, extensive expert knowledge is not needed for AI-based solutions, so they are much easier to put into service. The training data required in order to create the AI models can be generated completely automatically in **simulation environments** developed specially for this purpose. The advantage of simulations is that a large amount of data can be generated without a real robot system. Via a cloud-based web service, even unskilled workers can perform the simulation and subsequent training fully automatically simply by providing a CAD model of the component. The automatic configuration process also includes gripping, as the necessary gripping points are automatically generated and evaluated, and the most suitable gripping tool is selected for the task in question.

Dual-arm robot in reality and in simulation.



Picking different workpieces out of a mixed bin (left).



Separating entangled objects through intelligent motion paths (right).

Highly robust due to smart additional functions

Supplementary functions make it possible to pick objects that are difficult to separate, such as entangled parts, and to set them down accurately. With the help of machine learning methods, the software is also capable of **detecting entangled objects when they are still in the bin and separating them**. If such an entangled object is detected, additional trajectory points are sent to the robot controller in order to solve the problem intelligently. This additional technology reduces the number of failed grips and shortens the effective cycle time.

A further function is the **segmentation of bins and packaging materials**. This allows the point cloud acquired by the sensor system to be divided up into regions belonging to workpieces and regions belonging to the bin or packaging materials, such as cardboard boxes or packaging films. This can make model-based approaches more robust or, in model-free approaches, ensure that gripping points are generated only on the components.

High flexibility even when it comes to demanding tasks

AI-based object recognition enables the model-based recognition and picking of **different objects in mixed bins**. Even **transparent objects**, such as those made of glass and plastic, can be reliably detected and gripped by a special sensor developed in cooperation with Fraunhofer IOF.

If part variance in the bins further increases or if there are no CAD models of the parts, model-free solutions that do not require a product-specific teach-in phase can also be used. In such cases, the system uses machine learning to search for possible gripping options in the sensor data. A **hybrid gripping system** – model-based and model-free – is also feasible.

During the execution of a gripping or placement operation, inaccuracies or unforeseen general constraints may prevent a workpiece from being picked up or set down or may cause it to slip while it is being moved. To overcome these problems, Fraunhofer IPA is working on a flexible adaptation of the grip and trajectory based on tactile feedback.

Higher performance through AI

A reliable bin-picking system usually requires a high-resolution and expensive 3D sensor. For this reason, Fraunhofer IPA is working on a method to increase the resolution and accuracy of low-cost 3D sensors by means of an artificial neural network that uses color images, thus making bin-picking possible even without a high-end 3D sensor.

New developments such as **online learning** round off our range of services. Here, the robot system learns from mistakes and continuously improves itself thanks to intelligent processes, thereby increasing availability and efficiency independently.

Our services

Fraunhofer IPA offers a variety of bin-picking technologies and helps you plan, integrate and implement them. The range of services extends from single smart modules for solving specific problems to complete bin-picking software solutions.

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