Whitepaper

How to Qualify Parts & Determine Economic Feasibility for Robotic Bin Picking

The Future of Automation

Automating the bin picking process can dramatically increase productivity.

A robotic bin picker locates and picks randomly piled parts from a storage bin by locating and gripping parts then moving them to a final destination. Not all situations are ideal for robotic bin picking, but when you have a qualified part, automating the bin picking process can dramatically increase productivity while reducing dunnage and overall operating costs.

Every bin picking project starts with a vision and/or problem. These projects are most successful when the vision/problem is defined early and well detailed.

This whitepaper is a guide to help you solve a few important aspects of robotic bin picking: qualifying the part that will be transferred between bins as well as evaluating economic factors that influence the implementation of this type of robotic system.

Let's get started.

Bin Picking Types

Random Location of Parts in a Bin
This bin picking process is based on identifying the correct part, determining the location, and picking randomly placed parts from a bin or tote using robotic automation and 3D scanning systems. The 3D sensor is used to develop a 3D point cloud (topographic map) of the top surface of parts in the bin. Software running on a PC is then used to correlate solid CAD models to the topography of the parts. This data is then used to identify parts, check for possible collisions between the robot, parts, bins, and to determine viable pick orientations for the robot. The robot's programming is used to move the end effector into position to properly grip the part and exit the bin.

Structured Parts in a Bin
Structured part bin picking is the process of removing parts that are organized into layers (either via dunnage or layering) from a bin/tote using robotic automation. A 2D+ or 3D scanning system can be used for the application where the part position doesn't significantly vary in pitch or yaw from a flat orientation.

Considerations for Selecting a Bin Picking Vision System

Vision systems are necessary to automate part picking from a bin. Several different vision systems such as 2D stereo vision and 3D vision can be used. Regardless of the type, a vision system has to perform the functionality listed below in order to be a viable solution for bin picking.

Acquiring a Good Image of the Parts in the Bin
A good image is the most important aspect of any vision system. Image resolution, acquisition speed, and quality are some of the primary criteria to be considered when selecting a vision system. Better resolution means more data is available for processing algorithms, which makes the results more reliable and accurate. However, more data takes more time to process. Images acquired by a camera include relevant part data, but also include noise due to ambient light or random part reflections. The amount of image noise depends on the light used and the type of parts (metallic and shiny, dark and absorbing, or matte and textured).

Part Matching

In a picking application, finding the parts is the first step. Parts can be found by either matching the parts in the image to specific properties/features of the part, or matching to the 3D drawing of the parts. The chosen approach impacts the solution robustness.

Selecting the Best Part to be Placed & Avoiding Collisions

Once the parts are matched, the system determines which part should be picked. However, the system must also determine how to avoid collisions between the robot gripper, and bin. The extent to which a vision system provides this capability determines the complexity of the vision system's integration with the robot.

Communicating the Information to the Robot

Just like human hand/eye coordination, the robot needs to be aligned with the vision system, so it is able to pick any part. This alignment procedure needs to be rugged, quick and should result in accurate alignment. In addition, setting up a communication interface between the vision system and the robot is critical.

SICK's PLB system was developed for precise localization of parts in bins and boxes. It utilizes a 3D CAD-based teach-in of new parts for easy configuration of new applications and supports short pick-to-pick cycle times and high throughput. The system is comprised of a 3D camera and part localization software along with additional tools for easy integration with the robot and communication with a higher-level controller. The camera delivers accurate and reliable 3D images and is unaffected by ambient artificial light. The field-proven tools and functions for alignment of the PLB system with the robot coordinate system, communication with the robot and verification of collision-free gripper positioning relative to the part make it a simple matter to integrate the system in production. Both the software and hardware are designed to be used out of the box.
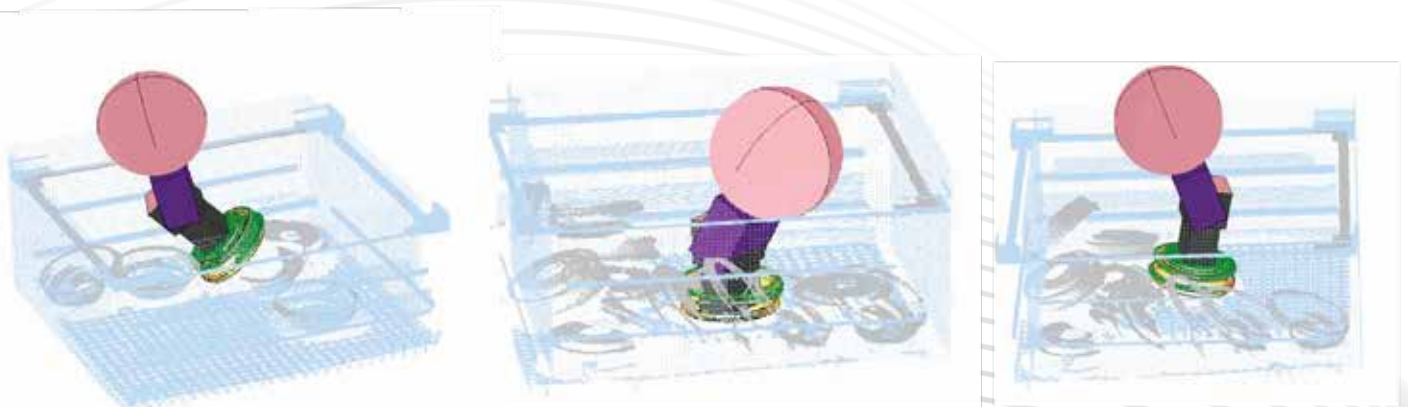
Snapshots of the SICK Vision System software displaying 3D mapping of the bin environment.

Types of Parts

Size
Part size is typically larger than those desirable in a feeder bowl system.
The target weight is 40 lbs. or greater.

Features
Oddly enough, the more features the part has the simpler it is to identify and determine orientation. Parts that interlock need to be closely evaluated.

Surface
Any part surface is usable; however, mirror surfaced parts are typically avoided due to the reflections created by the laser scanning systems. These reflections make communication between the vision system and the robot difficult and problematic.

Generalizations
Parts need to be dimensionally consistent. Gross variation from flexible or extreme deviations from rough castings will be identified as comparable to the solid models.

Part Examples

Parts that are ideal for robotic bin picking projects include steel parts such as gear blanks, brake drums, rough forgings, stone blocks, and fan parts.
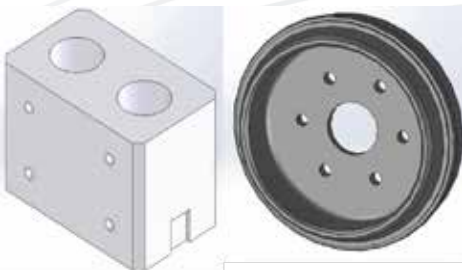
Bad Part Examples

- Parts can easily interlock with each other.

- Limited number of features for picking.

Good Part Examples

- Larger parts.

- Part has multiple features for identifying orientation.

- Parts are not able to interlock with each other.

Advantages & Disadvantages

Automating a bin picking operation has great advantages, but there are also disadvantages depending on your specific operation. Keep in mind all the areas of your business that will be affected by the implementation of a robotic system from the operators on the floor to the end customer:

- Target applications where ergonomics is an issue (i.e. removal of heavy parts from a bin).

- Part to part cycle time between 10-15 seconds per robot.

- Bin to bin transfer time needs to be accounted for in the overall process definition.

- Avoid interlocking parts.

- Programming is needed for every part number of variant. Some programming can be recycled, but some modifications are always needed.

- 3D bin picking finds parts regardless of changes in surface color or texture.

- Ferrous metal parts are preferred since magnets make a simple gripper.

- 3D vision system will work around some debris that may accumulate in the bin (i.e. leaves).

- Each application needs to be evaluated for feasibility.

Return on Investment

Typically, a vision-based picking system is more expensive than a conventional robotic loading system. However, when taken into account the justification of this process considers the following costs:

- Organized product if robotic removal is needed.

- Increased verification that correct part is picked.

- Increased storage density due to lack of dunnage.

- Less dunnage costs.

- Ergonomics related to the manual unloading of bins.

- Operator labor savings.

- Operator injury due to heavy part handling.

- Reduced noise as opposed to vibratory feeders.

The average Return on Investment is **less than 2 years** for bin picking with heavy parts, parts with sharp edges, and deep bins that result in reduced dunnage and operator labor.

Bringing it all together

Midwest Engineered Systems has built bin picking systems for a variety of applications. Our technical experience and knowledge base, in conjunction with our relationship with the most popular robot manufactures and peripheral vendors, gives us the ability to provide complex automation configurations for manufacturing applications.

Still unsure if your part would be a good fit for a bin picking application? Contact Midwest Engineered Systems to review your specific requirements, help you determine what equipment would be the most successful, and get a custom quote.

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The Future of Automation