Creating An Optimal High-Speed Robotic Picking Solution

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Since high speed robotic picking systems are now a proven packaging technology, companies are eager to gain instant productivity improvement from this solution.

A typical high speed picking application involves locating, inspecting, picking and placing products into the in feed of a packaging machine, such as a high speed flow wrapper. To optimize system throughput, high speed picking generally occurs "on the fly," allowing the robot to seamlessly move from one pick sequence to another without wasting precious time.

While advancements in robotic technology have allowed the pick and place operation to be performed in 0.5 seconds or less, the true success lies in the selection and interaction of all system components. Early evaluation of the following critical elements will promote project success.

- Formulating an accurate system specification
- Optimizing all elements of the pick-and-place cycle
- Product handling
- Robot selection
- System considerations (vision, conveyor tracking, etc.)

Formulating a functional specification

Creating an effective high-speed robotic picking solution begins with defining the primary operation of the system. Since many flexible manufacturing lines handle a family of products, it is essential to determine all of the product configurations, package configurations and production rates of each configuration that the system will produce.

The next step is to analyze the configuration of the products up stream of the packaging system. Many products require preconditioning prior to entering the robotic system. Preconditioning will improve the vision location and robotic handling of the product.

Optimizing the pick-and-place cycle

The objective is to minimize the move lengths of the robot. The robot movements account for 70 to 85 percent of the overall robot cycle time. The performance of a high-speed pick-and-place system is highly influenced by the laws of dynamics: the shorter the move distance, the shorter the cycle time.

The key task is to position the packaging equipment in the work cell to optimize the product translation distance. Lifting the product, from the product presentation conveyor, and lowering the product, into the packaging machine in feed, should also be minimized. The other critical element is to adjust the elevation of either the in feed system or of the packaging machine to minimize "Z" motions.

Product handling

The next task is to optimize the payload being transported by the robot. The lower the product payload, the faster the robot can move.

The product must be secured during its transport from pickup to placement. The robot could be accelerating and decelerating up to 12 times the force of gravity. These forces impact the stability of the product in the gripper as well as the potential for product damage by the gripper.

Product picking and placement consumes the remaining 15–30 percent of a pick-and-place cycle. The gripping time is the amount of delay in the robot motion required to secure the product for transport.

The two major categories for product gripping are vacuum and mechanical. Vacuum gripping is generally faster, lower weight, simpler, has no moving parts and the maintenance factors are lower. Mechanical gripping provides secure handling and more accurate positioning, which may prove advantageous in specific applications, but it may be slower and have lower reliability.

With either method, the early development of the design of the gripping system and extended prototype testing is critical to ensure validation of the concept prior to implementation.

Robot selection
After identifying the design considerations discussed above, the robot can be selected. When choosing a robot, consider:

- The number of degrees of freedom required to perform the operation.
- The work envelope needed for the application.
- The total payload, which is the sum of both the tooling and product weight and the distance that the payload is offset from the mounting flange of the robot.
- The true picks-per-minute performance. Again, extended prototype testing is critical to ensure validation of the concept prior to implementation. The picks per minute may exceed the capacity of a single robot, requiring additional units to make the overall system rate.

The majority of high-speed picking applications can be done with a four-axis mechanism. The mechanism that has the proven ability to perform high-speed pick and place reliably is the delta robot. The overhead mounting configuration of the delta robot provides a sizable unobstructed work envelope and the unique mechanism design provides equal performance from all servo axes, unlike many robot configurations. The robot can pick products from less than 50 grams to 3kg. in weight. With its built in flexibility, extremely fast cycle times, minimal wear and superior quality, it can offer users high productivity.

System considerations
The following components provide a valuable contribution to the overall system performance.

Robot Controller
Since the performance of robots is highly dependent on the capabilities and reliability of robot controllers, it is essential to choose a controller that:

- Has a motion control platform that provides accurate path control at high acceleration and velocities.
- Reliable integration to vision and conveyor tracking platforms.
- Complies with industry and environmental standards.
- Is easy to use and has flexible programming tools.
- Interfaces to peripheral component, system and hierarchal control systems.

Vision
Providing all of the pick locations to the robot makes the vision system a critical component. A vision system must be providing over 99.9 percent reliable data to the robot. Key requirements are:

- Vision data is transferred to the robot controller at an adequate rate to maintain uninterrupted robot operation. In many cases a single vision system is providing data to multiple robots.
- Accurate product location information, coupled with the conveyor tracking system, ensures successful pick locations.
- Inspection tools to detect product defects and eliminate them from being handled by the robot.

Since vision systems are highly dependent on achieving an accurate image of the product on the conveyor belt, vision lighting must not be overlooked. Selecting the correct lighting frequency, lighting position and most importantly an adequate contrast between the product and conveyor belt color will ensure the success of the vision setup.

Packaging machine interface

The robotic placement of the product into the packaging is the overall goal of the system. Since the robot is picking random oriented products from a stream of products that may have minor fluctuation in product flow. The packaging machinery must be able to interactively communicate with the robot system and actively respond to flow variations. The packaging machinery must also be correctly interfaced to the robot reacting to startup, shutdown and error recovery sequences.

Experienced resources

After assessing the specific aspects of an application, it is advisable to work with an experienced systems integrator for the development and implementation of the robotic system. Experienced integrators can be invaluable resources in the design and implementation of high speed robotic picking systems as well as providing the ongoing support and service essential to achieving long term system success.

All of the elements discussed are a driving for a common goal - system reliability, the true measure for success. When a robot system operates at 120 cycles per minute in a three-shift operation (approximately 22 hours per day), it performs nearly 40 million cycles per year. Reliable design and interaction of all system components contribute to achieving high system uptime for years to come.

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