

BREAKTHROUGH ROBOTICS EMPOWERING DISTRIBUTION CENTERS

Advances in Technology Are Finally Enabling DC Automation

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SUMMARY

Robots got their start in the workforce performing repetitive tasks in highly controlled manufacturing environments. The precision and repeatability of these jobs made them relatively easy for robots to master. Robots were also considered ideal for jobs that were dirty, dull or dangerous. Yet costs were high, both for the robots themselves and for the processes needed to upgrade to an automated workflow.

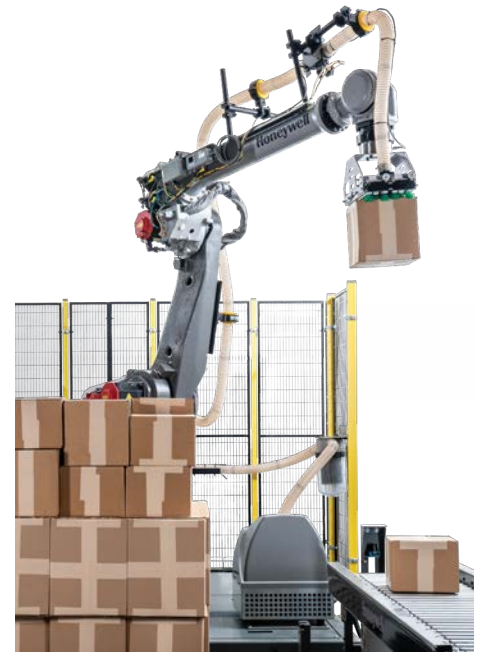
Tackling the more dynamic, unstructured environments of today's DCs calls for far more sophisticated robots. Unlike manufacturing, logistics tasks are unpredictable, inexact and frequently aren't repeatable. For example, the same combination of items may never be ordered by any other customer, or the DC may have switched to a different type of packaging by the time the same items are reordered. Meeting these challenges has required the industry to develop a new generation of smart robotics with higher degrees of spatial and object awareness. We're also seeing the development of powerful tools to simulate new solutions, optimize robotic operations, and even help robots learn new skills over time.

But how advanced *are* the latest robotics solutions? While they're not quite Rosie the Robot Maid, or more sinister humanoids like the Hosts from *Westworld*, they've made significant technological advances. Cutting-edge technologies are at last driving more capable logistics automation solutions which can meet the challenges of today's DCs.

The combination of superior computer vision, high-speed onboard intelligence, sophisticated gripping technology and other allied components now enables the automation of tasks that were previously handled manually.

As a result, competitive robotic solutions are now available for challenges that have traditionally been considered unsolvable. From artificial intelligence (AI) and machine learning to advanced gripping technology, autonomous navigation and systems integration, this white paper covers key advances in robotic technologies and the new capabilities they enable.

It's also important to remember that robots in and of themselves are not enough. While any supplier can claim to be able to customize robots for specific tasks, few have deep expertise in the needs and challenges of the logistics ecosystem. As such, this report concludes with a brief discussion of how to develop robotic systems capable of achieving their full potential in modern DC environments.



DISTRIBUTION CENTERS CREATE UNIQUE AUTOMATION CHALLENGES

1

Robotic applications have historically been easier to implement in environments that call for the same precise actions to be performed over and over, such as welding, painting or assembly in manufacturing.

DCs, on the other hand, are characterized by constant change. Robots have to deal with a wide variety of packaging, including cases, totes and polybags. And since a growing number of orders go directly to consumers, shipments of individual items are increasingly common, driving up the number of interactions needed to move the same volume of product compared to unit- or case-load handling.

Today's inventories are also more massive and diverse than ever before. The ability to give consumers exactly what they want, when they want it, is a huge competitive differentiator for e-commerce. That means robots must quickly adapt to seasonal inventory changes and new product introductions.

For each new SKU, logistics robots require significantly higher levels of spatial and object awareness than their counterparts in manufacturing. Smart robotics are needed to recognize items to be handled, understand dynamic work environments, and plan how to act autonomously. Most important of all, however, is to make sure your robotics integrator has end-to-end experience with DCs and their processes.



WORK SMARTER WITH ROBOTIC INTELLIGENCE

2

A new generation of robots, designed specifically for DCs, has been made possible by advances in five key technologies:

Sensors and computer vision

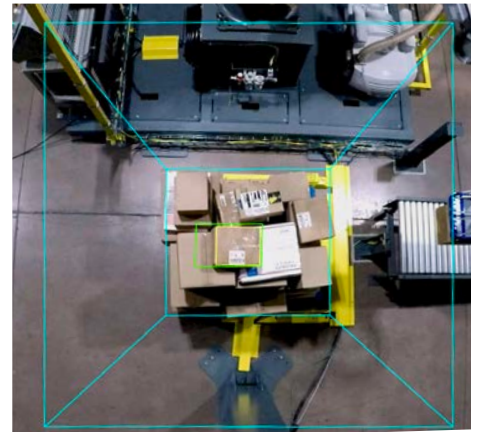
Today's robots are far more aware of their environments. A wide range of sensor technologies, including stereo 3D cameras, high-resolution RGB imagery, LiDAR and other structured light software, gives them new ways to perceive and navigate their surroundings.

In addition, modern robots are capable of combining data from these and other sensors to create a diverse multimodal awareness that enhances their perception.

Computing power

Robotic applications require speed to perform viably in complex environments like DCs and achieve ROI. Thus, the new generation of robots has been designed with significant processing power, allowing complex algorithms to process very quickly. The result is superior performance in every other aspect of the robot, from computer vision to motion and grasp planning. Performance data can also be leveraged to evaluate and improve robot productivity over time.

Modern robots can also use advanced simulation and physics-based emulation capabilities to learn faster. By combining perception and intelligence into virtual platforms, numerous different types of situations and scenarios can be generated. This allows robotic solutions to be more robust in the real world, further reducing the risks of deployment and achieving positive ROI faster.



Machine learning and AI

These two powerful technologies enable robots to perform advanced problem solving on their own while allowing humans to stay in the loop for training operations. Fully integrated into the newest automation systems, they enable robots to learn not only from their own experiences, but from the experiences of other systems, and even from different types of robots.

Connectivity

By harnessing the power of the cloud, advanced connectivity features provide meaningful performance advantages with fewer operator interventions. Over time, connectivity also helps identify opportunities to make ongoing enhancements. Once a single robot learns a new skill, its training model can be pushed out to others via robot-to-robot and even site-to-site machine learning.

Mobility

Mobile robots are among the fastest-growing automation solutions in DCs, thanks to their infrastructure-free navigation with simultaneous localization and mapping. These robots learn the layout of your DC and get to work quickly, moving cars, conveying loads and more. Advanced sensor and camera technologies allow the robots to navigate safely in dynamic environments, giving the right of way to workers and vehicles, and independently re-routing around obstacles if necessary. Improved battery technology and autonomous opportunity charging enable them to work continuously, shift after shift, 24/7. Fully integrated software solutions for planning, routing and managing the flow of a fleet of mobile robots enables optimal utilization, regardless of day-to-day operational variations.



THE RIGHT GRIPPING TOOLS FOR THE JOB

3

Recent advances in tactile sensor technology, which mimics the human sense of touch, are helping robot grippers work with greater flexibility and care. Robots equipped with these tools offer many options for easing the labor burden in the DC, either by working on their own or supporting human co-workers.

Many types of grippers are useful in DC applications. Key technologies used in Honeywell Robotics solutions include:

- **Vacuum** – One of the most popular tooling types, vacuum grippers use pneumatically actuated cups or foam to lift products. They work best with sturdy, traditional packaging, such as sealed corrugate cases that can bear the total weight of the product during transfer.
- **Fork** – Fork-style tooling uses a row of forks that comb through conveyor rollers to lift product from the bottom. This method is useful for handling irregularly shaped cases and bags, cases with lids, fan-fold cartons and any packaging that cannot support its own product weight.
- **Clamp** – Ideal for heavy loads, such as pallet lifting, side-clamp tooling is often used for packages that can't be handled with a vacuum tool. They can also work at higher robotic arm speeds than vacuum tooling, and provide greater control and confidence when gripping and transferring product.
- **Hybrid tooling** – Sometimes, a combination of vacuum, fork or clamp-style tooling is used to help constrain motion along both the x and y axes during motion, or peripheral tooling is added to handle pallets or tier sheets.
- **Flexible soft grippers** – Increasingly effective, thanks to recent advances in AI and machine learning, flexible soft grippers are used for individual item picking and other tasks which require high dexterity.

The software side of the job, known as *grasp planning*, is how a robot brain determines the best way to use any given gripping tool. Successful grasping depends on the flexibility of the tooling and the power of the grasp-planning system. The more flexible the tooling, the greater chance the robot has to succeed. Flexibility also means less precision is required of the robot's grasp planning, enabling greater variability in the product mix the robot can handle.

ROBOTIC APPLICATIONS IN THE WAREHOUSE

4

Palletizing and depalletizing

Palletizing and depalletizing are arduous, repetitive and injury-prone tasks that have long lacked flexibility and required large investments to automate. But that's changing with a new wave of robots able to place cases and totes not just onto pallets, but onto carts and autonomous vehicles. They're also capable of removing items from pallets, autonomous vehicles or other containers.

These systems can handle single-case, multi-case, layer and multi-layer picks. They can accommodate changes in packaging and labeling with no process adjustments. Advanced perception technology combines vision and sensor integration with powerful computational capacity, enabling items to be identified without the need for pre-scanning.

Smart flexible depalletizers from Honeywell Intelligated leverage artificial intelligence (AI), gripping technologies and motion planning, enabling them to seamlessly transition from mixed-SKU to single-SKU pallets in any sequence — from a single work cell to an integrated system — without requiring additional programming or operator intervention. This innovative approach to receiving and de-layering of unit loads provides warehouse and distribution centers the abilities to increase their technological footprint, meet expected ROI, and be better prepared for future growth and expansion.

Automated storage and retrieval systems (AS/RS)

This flexible and highly scalable solution has the capacity to pick cases and other containers from storage, transferring them onto complementary automation systems. More configurable than traditional systems, robotic solutions can accommodate a wide range of products and save valuable warehouse space by increasing the density of product storage. Robotics also offer a viable solution in some situations where an AS/RS doesn't fit the needs of the operation.

The system can be implemented quickly, even within existing workflows, and easily integrates with both traditional and mobile automation solutions. Advanced vision technology enables the robots to handle both single-size totes in fixed locations or varied sizes in dynamic positions.

When combined with fully integrated goods-to-person (GTP) fulfillment and inventory decant stations, AS/RS shuttles can deliver a 30 to 40% increase in throughput compared to traditional picking methods. To achieve its maximum potential, this unified solution can also leverage next-generation warehouse execution system (WES) software with Decision Intelligence to optimize inventory allocation in up to 40% less space, while reducing labor costs and achieving up to 99.9% order accuracy.



Smart flexible depalletizer



Automated storage and retrieval system



GTP station

Autonomous mobile robots (AMRs)

Transport workflows create a lot of inefficiency in manual DC operations. Significant labor can be tied up moving carts, driving forklifts, moving between pick locations, processing returns and more.

AMRs cut much of this walk time out of the equation, enabling you to deploy workers as efficiently as possible. They offer cost-effective automation on demand and can be deployed quickly in nearly any facility with minimal IT or infrastructural changes. An AMR system can also grow at any pace on an as-needed basis.

Mobile robotics have already proven their value in a variety of DC-related jobs, including:

- **Pallet conveyance** — AMRs can be loaded or unloaded directly with a forklift, or work independently via pick-up and delivery (P&D) stands.
- **Picking and cart transport** — Using AMRs to transport items to pack-out and shipping areas enables workers to stay focused, reducing pick times by nearly 50%. AMRs can also be used to transport returns in DCs or kits in manufacturing operations.
- **Replenishment** — AMRs can be used to transport goods to and from AS/RS systems, or to handle items that can't easily be moved by conveyors. They can also provide a flexible “bridge” between different conveyor systems in a facility.

Truck/trailer unloading

Robotic unloaders enable DCs to get valuable labor off the dock and reassigned. This relieves workers from arduous and repetitive tasks that are frequently uncomfortable to perform in the summer and winter months. It also eliminates exposure to high-risk tasks, with some of the highest rates of turnover, allowing workers to be shifted to more satisfying, higher-value positions.

In situations where trailers transport stacked products of a consistent size, vehicle-mounted articulated arms can do double duty by both loading and unloading trailers. These robots operate quickly and require minimal operator supervision or intervention. There's also no need to change processes or add supporting equipment.



Autonomous mobile robot (AMR)



Robotic unloader

INTEGRATION: FIND THE RIGHT ROBOTICS INTEGRATOR

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Successfully integrating robotic solutions into your DC requires more than just the latest technology. You need a robotic integrator who knows how distribution centers work, and how to ensure that smart robotics delivers real-world results for you.

Start by looking for a partner who is recognized by the Association for Advancing Automation (A3) as a Certified Robot Integrator, a designation that is only awarded to organizations which have already achieved high levels of proficiency, experience and success. Ask your partner for references, and if possible, arrange visits to existing sites that already use the solutions you're considering.

Your integration partner should have an extensive understanding of how robotics can be used across your entire organization. An end-to-end understanding of DCs, including their traditional processes and technologies, is critical to ensuring that you get a results-oriented solution.

They should also consider each robot as part of an entire system, not just a single piece of equipment. You'll need tight coordination among systems, including sortation, picking technologies, conveyors and software. An ideal partner will understand how to combine diverse, interdependent systems to deliver the maximum topline benefits.

Pay attention to the service you receive before you close the deal. Strong pre-order service is a good indicator of good post-order service. Remember, too, that installation and commissioning are two different skill sets. Does your robotic integrator have both? You'll also want to pay close attention to the level of ongoing support your integrator provides.



MAKING ROBOTS A REALITY IN YOUR DC

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The robotics revolution has finally arrived in the DC, and you can make the most of it if you deploy new solutions wisely. Here are four key takeaways to consider as you proceed:

- **Automation solutions are at various stages of maturity.** Much of the data for certain applications must be collected and understood to determine which approach is right for your operation.
- **Advance consultation with your integrator is critical.** Use simulation, emulation, expert consultation and pilot programs to make sure you understand each application and its variability. This will help you determine true value and calculate your ROI before you make major investments.
- **Closely define your scope.** Try to constrain variables and applications to keep each automation project as structured as possible. Establish objective success criteria that aligns with your vetted ROI and matches your business case.
- **Understand what robotic solutions can and cannot do.** Popular culture and YouTube videos make it easy to overestimate robotic capabilities. Make sure your assumptions are firmly grounded in reality.

Robots can play a critical role in improving your reliability, capacity, utilization and productivity. When properly integrated, smart robotics can make your DC work even better – and more profitably – than it does today.

Honeywell Intelligated

+1 866.936.7300

info@intelligated.com

sps.honeywell.com

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