BREAKTHROUGH ROBOTICS EMPOWERING DISTRIBUTION CENTERS

Advances in Technology Are Finally Enabling DC Automation

Honeywell Intelligrated®

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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 robots with higher degrees of spatial and object awareness.

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 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.

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DISTRIBUTION CENTERS CREATE UNIQUE AUTOMATION CHALLENGES

> **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 quantity 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. Another key to the success of automation is flexible gripping technology, which must combine the strength to lift heavy items with the dexterity to handle fragile merchandise without causing damage.

WORK SMARTER WITH ROBOTIC INTELLIGENCE

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

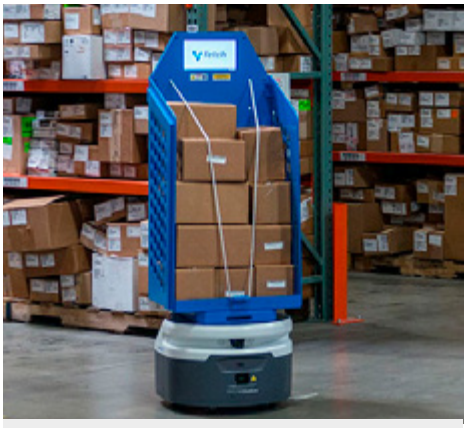
Sensors and vision
Today's robots are far more aware of their environments. A wide range of sensor technologies, including stereo 3D cameras, high-resolution RGB imagery, LIDAR and other structured light software, gives them new ways to perceive and navigate their surroundings. They also have an improved sense of touch, made possible by force feedback and tactile sensors that enable them to handle even delicate objects with greater care.

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

Mobility
Autonomous mobile robots are among the fastest-growing automation solutions in DCs, thanks to their infrastructure-free navigation with simultaneous localization and mapping. Improved battery technology enables them to continue working, shift after shift. Integrated sensors provide the data needed to navigate the DC while avoiding obstacles and rerouting when necessary. 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.

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, physics-based simulation and training capabilities to learn faster. By combining perception and intelligence into a simulation platform, 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 risk of deployment and achieving positive ROI faster.



fetch robotics

Strategic collaboration with Fetch Robotics enables the integration of autonomous mobile robots (AMRs), capable of moving loads up to 1,500 kilograms, often without any infrastructure changes. Vision and mapping technologies enable these robots to learn the layout of your DC and get to work quickly, moving carts, conveying loads, and performing RFID scans. They're also smart enough to avoid everything from people to fork truck tines.

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

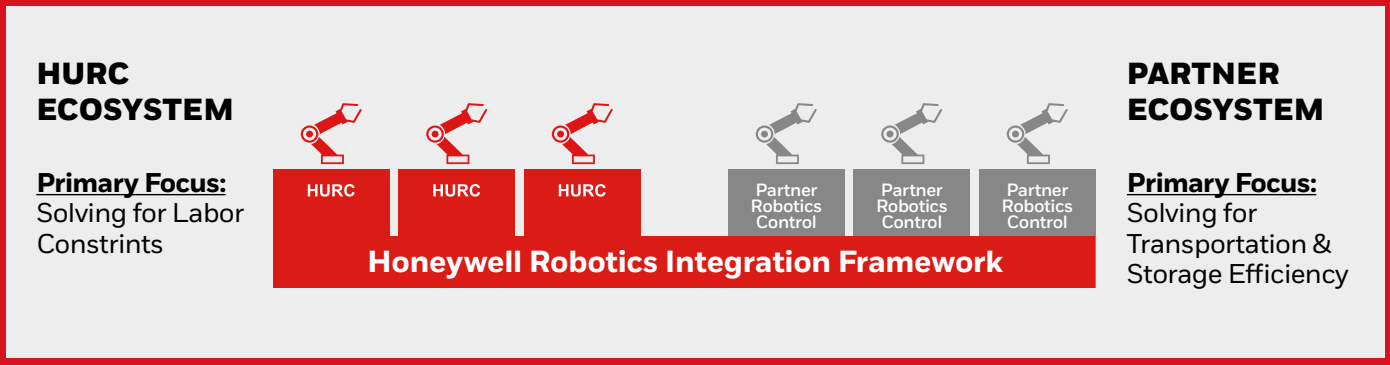
By harnessing the power of the cloud, advanced connectivity features provide meaningful performance advantages with fewer operator interventions. Over time, connectivity also helps identify opportunities to make ongoing enhancements. Once a single robot learns a new skill, its training model can be pushed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

Simulation

Physics-based simulation tools allow robotic solutions to be tested and evaluated in virtual environments, using the same control logic they will use in the real world. With a wide variety of product shapes, sizes and weights, simulations can show how the robotic solutions perform under individual product scenarios prior to deploying a solution in the real world. These powerful tools can identify where robots will be most effective while ensuring you get the best solution without relying on trial and error. This gives end users confidence that the solution will perform as expected and yield the necessary returns to justify the solution.

NREC
EXPERIENCE · EXPERTISE · EXCELLENCE

Collaboration with Carnegie Mellon University's National Robotics Engineering Center (NREC) led to the creation of a game-changing core technology: the Honeywell Universal Robotics Controller (HURC). Combining the latest sensor technology with substantial processing power, state-of-the-art machine learning and AI, HURC enables robots to see better, adapt to changing conditions faster, and even improve their own performance over time.



The Honeywell Universal Robotics Controller (HURC) Platform

HURC is an exciting new core technology that provides a single platform for next-generation robotic solutions. Designed specifically for the demanding needs of distribution centers, it generates the speed and robust processing power needed to handle massive volumes of data in real time, ensuring consistent performance.

This cutting-edge electronic "brain" can drive many different types of robots and will enable end users to respond to market needs more quickly by building off existing solutions. This is achieved in three ways:

1. HURC leverages lessons learned across the full spectrum of robotic solutions to improve performance in a wide variety of applications.
2. Common modules are used for key functions, including:
   - Sight (perception)
   - Thought (machine learning, planning)
   - Action (robotic control)
3. Advanced simulation capabilities based on physics enable faster development of new applications, using real-world data to create a virtual environment.

THE RIGHT GRIPPING TOOLS FOR THE JOB

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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.

SOFT ROBOTICS

AI-powered autonomous robots, available through a strategic alliance with Soft Robotics, feature gripping technology comparable to the human hand. These robots can automatically retrieve, sort and fulfill orders, and have already demonstrated the ability to perform more than 600 picks per robot per hour — from heterogenous or homogenous bins — with little or no human supervision.

ROBOTIC APPLICATIONS IN THE WAREHOUSE

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Loading/unloading

Robotic loaders and 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 many of the most dangerous jobs, with some of the highest rates of turnover, allowing workers to be shifted to more satisfying, higher-value positions.

While these tasks have long been a target for automation, previous approaches were hindered by prohibitive performance, integration and cost factors. Today, however, the newest advances in gripping technology and robot control systems are finally making efficient solutions available. Robotic dock workers now have the visual and processing capabilities needed to identify a wide range of package types and sizes, planning gripping actions accordingly for a range of tools at their disposal. The best solutions require no special modifications to trailers or containers and can handle everything from neatly stacked configurations to completely disorganized loads.

Robotic unloader

Each picking/item handling

E-commerce is driving a high and growing demand for individual 'each' picking. As with loading and unloading, multiple technological advancements have been required to enable the automation of these tasks.

Robust vision algorithms have provided the first piece of the puzzle by making reliable and consistent object detection a reality. Equally robust motion and grasp planning systems have also developed recently that are capable of driving whatever gripping technology the robot uses. As a last resort, a picking robot that encounters a situation it doesn't understand can call for help from a remote human assistant.

These functions will continue to improve as the speed and processing power of robot control systems increase.

Each picking/item handling

Autonomous transportation

In manual DC operations, there's a lot of inefficiency in the operator-to-goods workflow. Workers can spend up to half their time walking — including time moving between pick locations — instead of actually picking product. Adding mobile robotics cuts much of this walk time out of the equation, enabling you to deploy workers as efficiently as possible.

Mobile robots can also be used in a "goods-to-robot" workflow. In this scenario, mobile units can feed products to each-picking robots, replacing both order picking and conveyance, and bring the technology one step closer to lights-out fulfillment.

Autonomous mobile robot

Sorter induction and singulation

This solution frees limited labor resources from one of the most monotonous positions in the DC, making them available for other tasks. The robot is smart enough to identify individual items from batches, and has the vision, gripping and flipping abilities needed to pick up and properly orient items with their labels facing up. This not only improves the efficiency of downstream sortation and conveyer systems; it enables a DC to handle larger product volumes by loading as many sorter trays as possible.

Robotic sorter induction

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.

Automated storage and retrieval system

Palletizing and depalletizing

Palletizing and depalletizing are other 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, carts 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. Mixed-SKU applications are also now within reach.

Full-layer depalletizer

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 and understands the diverse needs of automation in your industry, and how to ensure they deliver real-world results for you.

Start by looking for a partner who is recognized by the Robotic Industries Association (RIA) 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. A deep 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.
- **Pilot programs are critical.** Use them 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.

Here at the dawn of The Connected Distribution Center, robotics can play a critical role in improving your reliability, capacity, utilization and productivity. When properly integrated, they can lay the foundation for a digital transformation today, while providing the data for even greater process improvements tomorrow.

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