ROBOTICS FOR RETAIL APPLICATIONS GUIDE

Optimizing retail fulfillment using machine vision and robotic technologies

COGNEX

THE GLOBAL LEADER

IN MACHINE VISION AND INDUSTRIAL BARCODE READING

Cognex® the leading supplier of machine vision and industrial barcode reading solutions.

With over 3 million systems installed in facilities around the world and over forty years of experience, Cognex is focused on industrial machine vision and image-based barcode reading technology. Deployed by the world's top manufacturers, suppliers and machine builders, Cognex products ensure that manufactured items meet the stringent quality requirements of each industry.

Cognex solutions help retail distribution, e-commerce, and parcel processing organizations improve operational throughput, increase traceability, and reduce costs by quickly and accurately reading barcodes, capturing dimensional data, and providing system level performance and feedback at every stage of the logistics process. Automating logistics functions using Cognex vision and barcode reading systems means fewer lost packages and less manual handling and rework, which equates to lower operational costs, higher throughput, and improved customer satisfaction.

$811 MILLION
2020 REVENUE

OVER 40
YEARS IN THE BUSINESS

500+
CHANNEL PARTNERS

GLOBAL OFFICES IN
20+ COUNTRIES

3,000,000+
SYSTEMS SHIPPED

TRANSFORMING RETAIL DISTRIBUTION & FULFILLMENT THROUGH ROBOTICS

AUTOMATION DELIVERS GREATER SCALE, EFFICIENCY, AND PERFORMANCE

Online consumer spending increased by 44% in 2020, to a total of over $860 billion, with online now representing over 20% of total retail sales[1]. At the same time, the average cost to fulfill an online order is 70% of the average order value[2], and each item can be manually handled 20 times or more[3].

Consumers now expect 1-2 day delivery, while refusing to pay extra for it, and speed of delivery is a significant criterion in choosing a retailer. Retailers competing with Amazon are trying out new distribution models, including buy-online-pickup-in-store (BOPIS) and direct ship to the customer. All are having to fulfill more single item orders from their warehouses and distribution centers.

All of this has put severe pressure on distribution centers with picking, packing, sorting, and shipping functions that could not cost-effectively meet delivery window expectations, either in direct shipping or in order preparation for store pickup. Hiring difficulties can make staffing appropriately a challenge, particularly for the growing grocery cold storage segment of the market.

ROBOTICS TECHNOLOGIES FOR RETAIL DISTRIBUTION

In response to these challenges, distribution and fulfillment centers are increasingly turning to robotics to replace humans in repetitive, physically strenuous tasks, saving employees for jobs with greater value-add. By one estimate, the average U.S. warehouse worker spends nearly seven weeks a year just getting from one place to another in the warehouse to do handling, picking, packing, and other tasks[4]. Robotics makes it easier to quickly modify and upgrade operations to meet changing market requirements.

Successful robotics implementations depend heavily on quality machine vision to guide robots, perform visual product quality inspections, measure, and inspect packages for pick and pack accuracy, and identify products as they move through the supply chain.

[1] *Digital Commerce 360* www.digitalcommerce360.com/article/us-ecommerce-sales/

[2] https://www.radial.com/sites/default/files/Order%20Fulfillment%20Final%20Report.pdf

[3] *AMERIPEN, Optimizing Packaging for an E-commerce World,* www.cdn.ymaws.com/www.ameripen.org/resource/resmgr/PDFs/White-Paper-Optimizing-Packa.pdf

[4] www.newcastlesys.com/news/new-motionmeter-app-enables-warehouses-to-easily-identify-hidden-causes-of-waste

AUTONOMOUS GUIDED VEHICLE (AGV)

Moving inventory, supplies, or bulk items once took a human and a forklift. Autonomous guided vehicles (AGVs) and smaller automated guided carts (AGCs) are taking over from forklifts, a process that has been going on for decades.

AGVs follow predetermined tracks, originally magnetic strips in the floor, but have been continually growing more sophisticated, and are now typically laser guided, using LiDAR, infrared, and vision systems to enable them to avoid collisions and position themselves accurately. Laser guidance means that routes can be quickly modified to meet changing requirements.

Aside from moving heavy bulk goods safely, AGVs now pull shelves of goods to warehouse employees who are picking orders, increasingly replacing, or extending belt conveyors.

Some AGVs now read barcodes and deliver to designated delivery points and are taking more of a role in sortation. They can travel to any divert or induction station along their path. This system can be modified much more easily than a conveyor system, adding AGVs, induction stations, and receiving receptacles without interrupting operations as needs change.

While making large DCs more flexible and lowering capital costs, such robots also make it possible for smaller businesses to establish warehouse operations, starting small and growing incrementally as needs increase.

For pallet scanning, AGVs equipped with Cognex barcode readers augmented by high-speed steerable mirrors can read the large number and variety of barcodes at the necessary speeds.

AUTONOMOUS MOBILE ROBOT (AMR)

An Autonomous Mobile Robot (AMR) is equipped with a variety of sensors, maps, and processing power that allows it to create its own routes to the required destination, instantly rerouting when encountering obstacles.

Zone-picking AMRs of various types know where goods for picking are to be found and often help humans locate desired SKUs by pick-to-light and other methods. Once the order is completed, the AMR moves its container to the next zone, and when the order is completed, to the packing station.

In Goods-to-Person (G2P) operations, AMRs can move mobile shelves containing the desired item to a picking station, wait in line with other shelf-toting AMRs, where a human, directed by pick-to-light or other methods, picks the item off the shelf, and puts them in the order bin. The AMR leaves the station and either proceeds to another picking station for a different order or returns the shelf to its park location.

Even more sophisticated AMRs equipped with vision systems and arms equipped with various forms of picking tools such as forks, or conveyors are increasingly able to pick the items themselves.

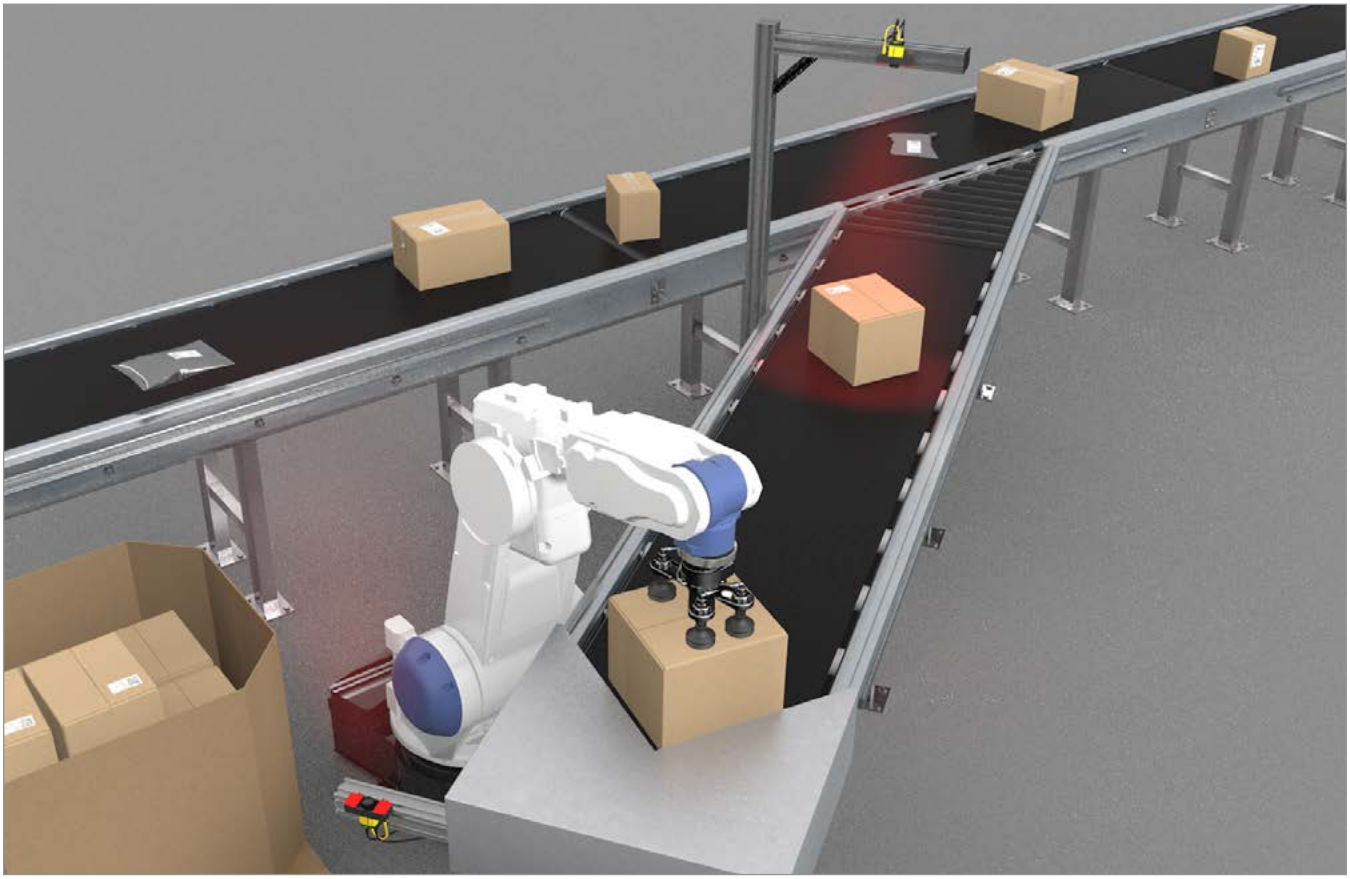
AMRs are also increasingly working in the front of the store as well as behind the scenes, moving through store aisles to pinpoint locations where items are out of stock and sending the images to store associates, detecting hazardous spills that might lead to slip-and-fall accidents, and interacting with customers.

Both AGVs and AMRs depend on robust data-collection and data-analysis tools compatible with existing warehouse management systems. And they recharge themselves when not in use.

AMRs can use machine vision to read 2D codes posted on the floor to navigate a warehouse grid, or, in more complex models, combine vision with LiDAR to gauge distances to help in maneuvering.

AMR vision can also identify objects by barcode or, with either rules-based programming or deep learning, by sight alone, enabling them to pick desired SKUs out of a group of similar but slightly different products more effectively than humans can.

ROBOTIC ARMS



Robotic arms have long been routine in industrial applications, where they perform a wide range of activities including machining, welding, paint spraying, and pick and place for assembly. This technology has made in-roads into forward-looking logistics operations as well.

Robotic arms are multi-jointed, with a variety of end effectors (grippers) that can lift, push, pull, turn, and otherwise move objects to the desired position. Their initial uses have been to replace humans in physically challenging, repetitive tasks, such as inducting items onto conveyors, sorting systems or AMRs, de-palletizing and racking incoming products, palletizing large orders for shipping, and sorting units into outbound shipping lanes.

Robot arms with proper safety sensors can work alongside human workers as cooperative robots (cobots) at a goods-to-person workstation, with humans taking the harder-to-distinguish, heavier, and more oddly shaped objects while robotic arms handle the rest. So, these robots are increasingly being implemented at fixed G2P workstations for order fulfillment—turning this into Goods-to-Robot, G2R.

Capable vision systems are essential to accurately guide the arms under challenging lighting conditions to find variously shaped and oriented items and identify them despite reflections and other visual confusion. Many logistics organizations are exploring the use of deep learning combined with machine vision to help with issues such as using OCR to read text on boxes or product, damage detection, item detection (was the correct item picked), and aesthetics (i.e. fresh, unblemished produce).

AUTOMATED STORAGE & RETRIEVAL SYSTEMS (ASRS)

Starting in Europe, where space and labor are at a premium, automated storage and retrieval (ASRS) units are essentially large, enormously capable vending machines. They can be many stories tall, with hundreds of thousands of storage cells within, or much smaller, serving individual stores.

In addition to being built into the hearts of an increasing number of DCs, ASRS systems are turning up in a variety of locations, including existing retail infrastructure. Grocery retailers are inserting them into existing stores where they will take online orders and fill totes for human pickers to fulfill. The increased inventory storage density, increased order picking accuracy, and increased throughput of these G2P systems make them increasingly popular.

ASRS systems come in a variety of configurations. They include vertical and horizontal carousels that move the product storage location to the operator, large-capacity vertical lift modules that use an inserter/extractor to pull and move a tray, fixed and moveable unit-load aisle systems with cranes that pull entire pallets, and shuttle or AMR-based systems that use either tracked shuttles or AMRs to retrieve trays. Operators are shown item and quantity to put into the order, typically through a pick-to-light system, then the ASRS moves another tray into place.

ASRS applications use a range of machine vision technologies assist with their operation including facilitating the processing of incoming inventory, determining product volume for storage optimization, and assisting tote carriers within the system in finding the right storage location. Machine vision plays a valuable role in preventative maintenance. For example, vision systems can check wheels on robotic carriers for excessive wear or broken bearings, which can save time and money associated with unplanned downtime.

HOW COGNEX MACHINE VISION ENABLES ROBOTICS

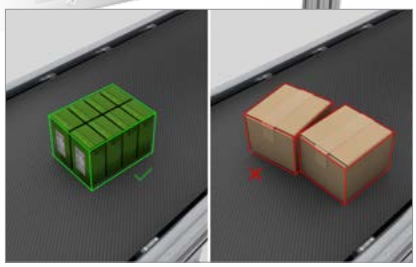
Machine vision plays an essential role in automating logistics operations, and this is equally true in the world of logistics robotics, where it provides guidance, identification, gauging, and inspection capabilities.

No matter what their own vision capability, robots work with existing Cognex scan tunnels and presentation readers to identify products and streamline the fulfillment process.

Cognex 3D vision systems use dimensioning and item detection capabilities to improve process efficiency and quality of operations. Application examples include ensuring that carriers are clear after an order is prepared and packed, detecting defects in product or packaging quality, and capturing dimensional information on incoming items to optimize storage processing. In addition, 3D vision systems can also detect when totes are full or too damaged to be in service, as well as determine when two items are too close to each other on a conveyor (which can cause fulfillment errors) when inducted by robots.

Detecting if a tote is full

Detecting a bulge on a package



Detecting a 'side-by-side' condition which can lead to fulfillment errors

CONCLUSION

The pandemic has boosted the growth of e-commerce, but it has only accelerated existing trends. Consumers have grown to expect fast and accurate delivery, while retailers face high costs, scarce labor, and operations that simply cannot meet current expectations. They face the need to manage an exploding number of SKUs in fulfilling more single-item orders and know that changes in the market will continue, making it difficult to make effective capital investments.

Robots, with their increasing capabilities, are an increasingly cost-effective way to meet these challenges. They can work alongside human beings, take on the more physically demanding and repetitive tasks, and use space with increasing effectiveness. They will infiltrate both warehouse and storefront, ensuring that stock is maintained, and deliveries are made quickly. Logistics managers will have many different systems to choose from, but all know that robots are part of their future.

IMAGE-BASED BARCODE READERS

FIXED-MOUNT BARCODE READERS

Compact but powerful DataMan® barcode readers offer unmatched code reading performance with patented 1D and 2D code reading algorithms. The flexible options, easy setup, and quick deployment make them ideal for the most demanding industrial applications.

HANDHELD BARCODE READERS

Versatile DataMan barcode readers provide best-in-class performance for 1D, 2D, and DPM codes, where ruggedness and speed are critical to success. A range of field-changeable communication options ensure these readers are ready to meet your application requirements.

MOBILE TERMINALS

The MX series of vision-enabled mobile terminals leverage the latest iOS® and Android® smartphones in a rugged housing, tough enough to stand up to the most challenging environments—all while providing superior 1D, 2D, and DPM code read rates.

BUILD YOUR VISION

2D VISION SYSTEMS

Cognex machine vision systems are unmatched in their ability to inspect, identify and guide parts. They are easy to deploy and provide reliable, repeatable performance for the most challenging applications.

www.cognex.com/machine-vision



3D VISION SYSTEMS

Cognex In-Sight laser profilers and 3D vision systems provide ultimate ease of use, power and flexibility to achieve reliable and accurate measurement results for the most challenging 3D applications.

www.cognex.com/3D-vision-systems



VISION SOFTWARE

Cognex vision software provides industry leading vision technologies, from traditional machine vision to Deep learning vision software, to meet any development needs.

www.cognex.com/vision-software



BARCODE READERS

Cognex industrial barcode readers and mobile terminals with patented algorithms provide the highest read rates for 1D, 2D and DPM codes regardless of the barcode symbology, size, quality, printing method or surface.

www.cognex.com/barcodereaders



COGNEX

Companies around the world rely on Cognex vision and barcode reading solutions to optimize quality, drive down costs and control traceability.

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