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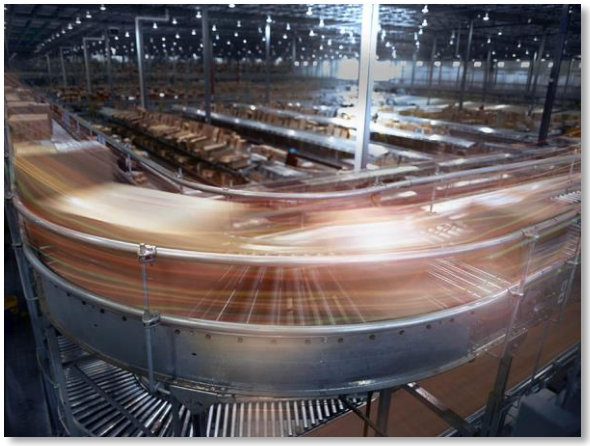
Ideal Applications for Cameras in Retail Distribution Centers

When deployed strategically within a facility, this image-based data capture technology offers benefits beyond its ability to read 1D and 2D codes.

Retail distribution centers (DCs) face continuously expanding throughput and accuracy requirements as they strive to meet their customers' expectations—whether shipments are destined for brick-and-mortar storefronts via truckload, or sent by a parcel carrier direct-to-consumer. A DC's ability to quickly and successfully capture inventory information through its various processing areas, at increasingly high speeds, is often a critical component of a company's success.



DCs must implement automatic identification and data capture (AIDC) technologies to read and process the information applied to products. The chosen system, or combination of systems, must be able to read data at the individual (each), case and pallet level in one of two forms:

- **Linear / 1D bar codes:** Data encoded in patterns of dark lines and light spaces, these can include UPC, EAN, Code 128, Code 39 and Interleaved 2 of 5 formats.
- **Matrix / 2D codes:** Data encoded in round or square patterns of dark and light dots, including PDF 417, DataMatrix, Maxicode and QR code formats.

Utilizing a Multi-Modal Approach for AIDC

When it comes to reading 1D and 2D codes, two primary families of identification technology are available in the market: laser-based (either line scan or omni-directional) and camera/ image-based (area array and line array).

It is important to understand that both laser- and camera-based data capture technologies have their place in a retail DC. For some applications, laser and camera can be used together. One does not have to replace the other in all situations. Applying a multi-modal solution that selectively integrates camera-based technologies with new or existing laser-based technologies can yield a variety of process-based benefits while maintaining a sensible investment strategy.

When properly applied and installed, either of these technologies can achieve read rates in excess of 99.5%—or even 99.9% in some operations. Therefore, it is critical to work with a supplier who understands the key differences, and can help identify which solution is the best fit for each application within a facility and throughout a supply chain. Taking a balanced, multi-modal approach, by stepping strategically into camera technologies by cost-effectively and

selectively integrating them into an existing laser-based AIDC architecture, can maximize a return on investment as well as ensure the highest levels of operational performance.

This white paper focuses on the points within a retail DC where cameras offer the greatest benefits and maximum return on investment.

Camera Technologies: An Overview

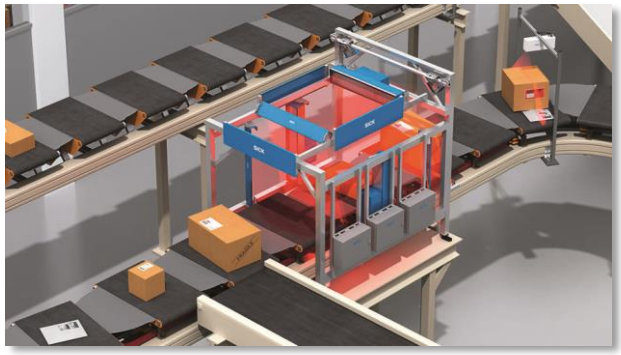
Also known as image-based code reading technology, cameras possess a scan engine that can read both 1D bar code and 2D matrix codes omni-directionally (in any orientation).

Cameras come in two styles:

- **Area Array Cameras:** Utilizing a two-dimensional data capture imager, these cameras capture a full image of an entire region of an item, case, or pallet at one time—similar to a snapshot taken with a digital camera. The image area is measured in pixels; for example, a 1024 x 768 pixel sensor captures a rectangle-shaped image at that resolution. The camera takes multiple pictures, capturing anywhere from five to 100+ images per second, depending on the capabilities and actual resolution of the individual device. The images are decoded by the camera, which transmits the information to upper level control systems.

  Due to their image speed limitations and field of view (generally less than 16 inches wide), multiple cameras are typically required over a conveyor line for code reading. To ensure that a code is fully captured, two to six area array cameras must be set up side-by-side with a minimum 4-inch overlap of fields. In a situation where multiple area array cameras need to be used for adequate coverage, a single line array camera might be more cost-effective while offering improved capabilities.

- **Line Array Cameras:** Utilizing a one-dimensional array of pixels on a sensor, this camera technology takes the picture differently than the area array camera. Instead of taking the full image in one snapshot, this device acquires slices of the image progressively as the item moves through the illumination field. This technology produces extremely high-resolution images, even at very high transport speeds; the newest devices on the market are capable of 30,000 scans per second at an image width of up to or greater than 8,000 pixels. The resulting high-resolution images produced make this system ideal for reading the widest possible range of codes. The lines are assembled in a two-dimensional image of the code, enabling optical character recognition (OCR) or other external image processing. Integrated code grading tools also tend to be more accurate and consistent in line array camera systems then those in area array cameras due to the



improved illumination consistency throughout the field of view, and the continuously adjusted focal distance.

Because of how they function, line array cameras have an inherently large field of view (the limits of the image area that can be captured by the camera) and depth of field (the distance between the nearest and farthest objects that can be captured in acceptably sharp focus). This technology is typically more costly than an area camera; however a single line array camera can cover a 40-inch wide conveyor with 36-inch tall cartons, which could take 2, 3 or even 4 area cameras in some cases, making it the more cost-effective solution with premium performance.

Ideal Applications for Cameras in Retail DCs

Because of their ability to read any type of 1D or 2D code and to generate an image as large as the side of a pallet load (depending on the installation), the ideal applications for camera-based solutions in retail DCs are at a point of divert or induction within an automated conveyor system. Again, cameras can be added exclusively, or integrated with laser scanners for a multi-modal installation.

Fixed-position cameras are frequently mounted line-side in up to six axes to cover all six sides of a target item (each, case or pallet): overhead, all four sides, and underneath between gaps in belting or rollers. The information captured by the camera(s) is routed to the warehouse management system (WMS), which determines the scanned item's destination.

For example, a five- or six-sided scan tunnel can be set up at the point of inbound receipt of pallets or cases. Applied to fully automated handling, the system accommodates a range of package and label sizes marked with inconsistent code types, quality and placement. This application could use cameras (solely, or in combination with laser scanners—such as with one camera placed overhead and underneath, where the majority of labels are located) to quickly identify and route product to its next destination, such as storage, forward picking, cross-docking and more. The cameras capture images to document and record any read errors that may occur.

Likewise, at retail DCs handling inbound receipt of eaches—with cases broken open for storage of individual items to fulfill catalog and e-commerce orders—fixed-position area array cameras that permit hand presentation at any angle can be implemented. These hands-free devices allow operators to work ergonomically while reducing the required hardware investment associated with handheld RF terminals.

Further down the conveyor line within a facility, cameras might be located at various routing points to identify an item. The data captured is used to verify its destination, then activate a divert or induction to a different area of the facility (storage, forward picking, cross-docking and more).

For facilities producing labels for outbound shipments to other partners in the supply chain, or direct-to-consumers, a scan tunnel equipped with cameras can verify the print quality and proper placement of a code sourced by an automated label print and apply machine.

Benefits of Cameras-Based AIDC to Retail DCs
In addition to their ability to read any type of 1D or 2D code, the digital picture that cameras capture can be useful in many ways.

1. **Reading Damaged or Poor Quality Codes:** Thanks to sophisticated algorithms, camera-based scan engines can make mathematical interpolations to interpret the missing data—essentially filling in the blanks.
   Some examples of printed code symbol problems that may see improved readability characteristics include code contrasts below 30%, insufficient quiet zone and vertical voids caused by a missing print element. Users may choose to invest in camera/image-based code reading technology in an effort to maximize read rates.

   Additionally, the captured digital image can be sent electronically to the source of the shipment for documentation of the code read error and subsequent root cause analysis, such as operational influences such as a misaligned or rotated carton, damaged label or poorly-printed code.

2. **Vendor Compliance for Code Placement:** Certain retailers and carriers require suppliers to place a code-bearing label in a consistent location on a case or parcel to accommodate their supply chain's handling practices. Non-compliance can trigger a financial penalty, or chargeback, that can negatively impact a supplier or DC's revenue.

   As with the previous example, the camera technology's ability to capture an image of the entire side of the case or pallet documents the error at the inbound point of receiving. Archiving the image at the outbound point enables the label's producer to document the proper placement of the code. The images can be used later for analysis and process corrections.

3. **Code Qualification:** Quality standards for 1D and 2D codes have been established by International Organization for Standardization (ISO) and the International Electrotechnical Commission (IEC). Quality is assessed based on different characteristics, including symbol contrast, modulation and time to decode, utilizing quality control verifiers. The verifier assigns a grade, or rating, typically on a numeric scale. Because speed of decoding is important throughout a supply chain, most trading partners establish a minimum acceptable code grade for their operations. Non-compliant codes that do not meet the minimum grade are subject to chargebacks.

   To be clear: A camera-based imaging system is ***not*** a verifier. However, the images captured by camera-based scanners can be used to perform "qualification," or in-line monitoring, of the quality of a code. A camera-based system reads and analyzes every symbol that passes by it, measuring it against preset parameters regarding print quality. When coupled with data collection and analysis software, trends regarding even minor changes in a code's characteristics can be identified. By tracking these changes over time, operational issues—such as dirty or burned out print heads, clogged ink jet nozzles, dirt, wrinkles or other defects—that reduce the symbol's grade can not only be identified, but also predicted. This allows a facility to both implement corrective actions and improve overall preventive maintenance activities to prevent a slow-down in production.

4. **Quality Control:** Camera-based imaging systems can be set up to verify and document the contents of a carton for confirmation that the right items were picked in the correct quantities prior to case sealing and shipment. The condition of the box upon departure or receipt can also be digitally documented and archived. Should the receiver report damage to the package and its contents, or that items are missing from an order, the photographic evidence can be retrieved for confirmation and picking validation.

5. **Process Evaluation:** Because they can be set up to capture an expanded field of view, cameras can also be used to examine the package and the surrounding automation technologies handling it. For example, if cartons are consistently being damaged somewhere along the conveyor line, the images captured by cameras can be useful in determining the cause and its location—such as incorrect or inconsistent spacing between items, wrong placement on the conveyor, or undersized/oversized loads.

Summary

As camera technology continues to evolve and become more cost-effective, the discussion as to what other things the user might want to do with the image will drive the identification technologies used within retail distribution networks. But, for now, camera-based technologies remain one possible AIDC solution among a broad arsenal of technologies, with advantages that lie beyond their ability to read both 1D and 2D codes. Among the benefits are quality and process control analysis; documentation to manage vendor compliance; troubleshooting for the root cause of problems with codes and labels; and verification of their placement on the eaches, cases, and pallets they identify.

Through proper application of the right technology in the appropriate areas of a facility, retail DCs can benefit from efficient, cost-effective solutions to their data collection. Partnering with a strong AIDC vendor—one that offers a full solution portfolio of diverse, complementary technologies that can be applied in a multi-modal approach—will benefit your technology evaluation and selection process, as well as produce the ideal solution for your operations.

Need more insights into how to select the right camera technology for your retail DC and handling application? Contact Jim Anderson, Vision Product Manager, at jim.anderson@sick.com.