Whitepaper

Machine Vision Streamlines Supply Chains

TECHNOLOGY ADVANCES MAKE VISION SYSTEMS MORE FLEXIBLE AND EFFECTIVE, ENABLING FASTER AND MORE ACCURATE MANUFACTURING, PACKAGING, AND DISTRIBUTION.

With increasingly interconnected systems and exponentially growing quantities of data, industrial operations must consider not if a cyber attack will occur, but how to respond when it does. Robust data and software system management can prevent production downtime during normal operations and ensure resilient recovery when the worst occurs.

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Sensor Intelligence.

Across a wide swath of industries, supply chains are tangled, broken, or slow and the data needed to streamline processes is missing or inaccurate. Machine vision technology untangles supply chains through automation—quickly and efficiently turning physical characteristics and codes into data. Part and product manufacturing, packaging, and distribution all benefit, and advances in vision system technology deliver returns on investment quicker than ever. Here, we'll explore what machine vision technology is, what automated tasks it can perform, and what users can expect regarding set up and operation.

Machine vision technology involves using digital cameras and image processing software to replace or augment manual tasks. This hardware/software combination creates code readers that communicate physical characteristics in digital terms, enabling fully automated processes. Most vision systems also use peripheral equipment such as photoelectric switches for image triggering, mechanisms to reject faulty objects, and touch-panel operator interfaces for monitoring and control.

Machine vision tasks can be categorized into one (or more) of four main tasks: positioning, inspection, measurement, and/or reading:

- Positioning is the task of detecting and locating objects, then reporting the presence or coordinates of the object.
- Inspection is the task of verifying product quality, e.g., checking the presence of parts of an assembly or finding defects and deviations.
- Measurement is the task of determining object dimensions such as length, width, height, area, and volume.
- Reading is the ability to read text and decode symbols. It encompasses technologies such as optical character recognition (OCR), optical character verification (OCV) and the reading of one- or two-dimensional codes.

Reading 1D and 2D codes

One-dimensional (1D) barcodes (Figure 1, left) are linear codes that consist of vertical lines of varying widths with specific gaps resulting in a particular pattern. Two-dimensional (2D) barcodes (Figure 1, right) are more complex, generally encoding data in square or rectangular patterns of two dimensions. Typically, 2D barcodes represent more data per unit area than 1D barcodes and, more often than not, support a bigger character set. 2D barcode types are relatively new and need support from more complex scanning devices.

Usually, 1D barcodes encode a string of numeric characters such as product number, production date, type, size, and so on. To add text information into 1D barcodes, Code 39, Code 93, and Code 128 can be used. QR codes and other 2D barcode

Older 1D barcodes (left) typically represent less data per unit are and support a smaller character set than newer 2D codes (right).
(Source: Stock.Adobe.com)

formats store large amounts of data, which allows for more flexible use. Another advantage of 2D barcodes is that they can encode images.

If the coded information contains only numeric characters, barcodes that support alpha-numeric or ASCII character sets can be used. More physical space may be required to store the data, but there will be more flexibility, as more types of information can be accommodated in the future, if needed, without changing the barcode type.

Direct part marking (DPM) is a process to permanently mark parts with product information such as serial numbers, part numbers, dates, and 1D or 2D codes. DPM allows the tracking of parts through the full life cycle of a product or assembly. DPM is often used by automotive, aerospace, and electronic manufacturers to facilitate reliable parts identification. This can assist in data logging for safety, warranty issues, and in satisfying regulatory requirements.

Code reader characteristics

Code readers capture the data housed in machine vision codes. The digital cameras and image processing software must be flexible, stable, and easy to install and configure. The cameras must deliver excellent vision capabilities and expanded functionality and be easy to focus and use. Characteristics include:

- Flexibility: Code readers for machine vision should be suitable for many applications such as identification of DPM codes on printed circuit boards, automotive component code reading, side reading of codes on totes, identification of DPM codes on electronic components, code identification on conveyor lines, and many more.
- Vision capabilities: Readers must allow consistent code identification regardless of the surface or code color. It must read small codes with short reading distances, weak contrasts, contamination, or low code quality.
- Size: Code readers for machine vision should be compact—usable where space is limited.
- Complexity: Readers should be easy to use. They must be virtually ready to use "out of the box," with minimal assembly and simple mounting.
- Functionality: The setup software should be robust and free. Setup should be accomplished by clicking a few buttons.
- Focusing ability: Code readers for machine vision should be easy to focus—preferably automatically adjustable.
- Cost: In addition to being easy to use, readers should be affordable.

Lector61x and Lector62x Code Readers

The Lector61x and Lector62x family of image-based code readers from SICK satisfy all code reading requirements. Compact construction includes a connector with flexible cable routing, and optical design that enhances magnification. The reader is suitable for industrial and logistics applications that require stable and fast code reading.

The Lector61x and other readers in the 6xx family are small devices designed to read and identify miniature codes. Due to its compact housing, the reader can be used in machines with tight installation space. The Lector62x is immune to ambient light and includes extensive optical accessories such as polarizing filter or a dome attachment.

The Lector61x is suited for automatic identification and decoding of 1D and 2D codes on moving or stationary objects. It also reads and identifies direct part marking (DPM) codes. Code reading is possible even on low-contrast surfaces or the glossy surfaces of printed circuit boards (Figure 2). In read mode, it transmits the read results via a host interface to a higher-level computer or programmable logic controller (PLC) for further centralized processing.

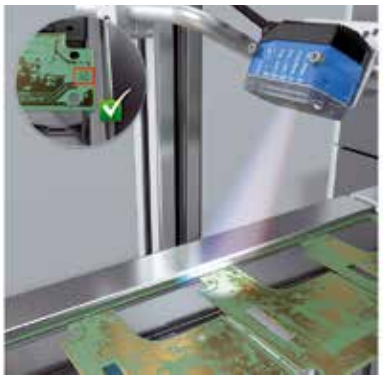


Figure 2. The Lector61x code reader is well-suited for direct part marking (DPM) applications like printed circuit board production.

Advanced liquid lens technology

Just as codes have evolved to be more complex and data-rich, code readers have advanced to be more effective and flexible. The focus position of the Lector61x image-based code reader can

Lector61x image-based code reader characteristics

Lector61x and other readers in the 6xx family are small devices designed to read and identify miniature codes. Its features and characteristics include:

- A powerful DPM code reader.
- Compact design.
- Snap-in mounting.
- Focus position can be adjusted automatically via liquid-lens technology.
- Includes controllable multicolor lights with optional polarizing filter.
- Magnifier effect for detection of the smallest codes.
- Easy auto setup.
- Integrated laser distance measurement (time of flight).

be adjusted automatically via SICK's liquid-lens technology (Figure 3). The front screen does not need to be removed during focusing as with manual-focus units. The built-in distance sensor provides feedback as soon as the image is sharp. An adjustable focus position—from 50 mm to 300 mm—ensures maximum focusing flexibility.

A setup wizard guides users through the parameterization process. The Lector61x adjusts itself automatically. Automated parameter switching enables the code reader to handle changing read conditions, which facilitates a high read rate.

Figure 3. SICK's liquid lens has no moving mechanical parts making it resistant to shock and vibration.

The liquid lens has no moving mechanical parts making it resistant to shock and vibration.

The shock and vibration typically found in industrial settings can degrade image quality and require code reader repositioning or recalibration. However, the liquid lens has no moving mechanical parts susceptible to shock and vibration. If movement causes the lens to go out of focus, it can respond instantly.

Traditionally, the course of light through a lens is controlled by a series of polished optical elements. These curved discs bend light as it passes through the optical path. With the correct spacing between lens elements and the sensor, an image should arrive at a single fixed point, sharp and in focus. Small, fast, and sturdy liquid lenses use a small pocket of fluid instead of physical discs, changing shape to direct and focus light.

Liquid lenses change shape (and therefore focus) by an electrowetting technique that pairs water with a separate layer of non-conductive oil, which sit together in the lens. By applying voltage across the boundary between the two, the curvature can be rapidly altered. The main advantage of liquid lenses is their ability to alter focal length without moving mechanical parts, allowing them to be kept small and light.

Machine Vision Applications

Machine vision technology is used in various industries to automate production and improve product quality. Applications range from basic tasks, like presence detection, to complex real-time inspection, grading, and track-and-trace tasks in harsh environments. Machine vision systems can ensure packaging confirmation/identification. They can confirm that the correct product is put inside the proper container with the correct label and the barcode will identify it as the correct label. For example, as long as the appropriate codes are in place, machine vision can prevent automated systems from loading a rack with a product that's supposed to be gluten-free with non-gluten-free products.

Here are some examples of applications in which the Lector 61x and Lector 62x family of image-based code readers are already proving beneficial.

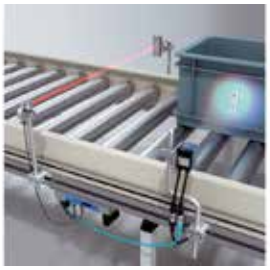
Traceability of engine blocks. To ensure gap-free traceability in the production of engine blocks, dot-peened 2D codes are attached to the cylinder heads (Figure 4). Lector 61x code readers reliably identify the codes the surface quality.

Figure 4. Engine block traceability application.

Identification of small samples. Identification of 1D and 2D codes in sample carousels (Figure 5) is another application where the Lector61x excels. Identifying codes in this application is difficult due to the limited space available. However, the code reader's small design and flexible cable routing enables reliable code identification, even in very tight spaces. The integrated special optics with magnification effect can read the smallest codes with up to 0.02 mm (1D code) and 0.04 mm cell size (2D code).

Figure 5. Small sample identification application.

Totes for material handling. Totes used in material handling applications (Figure 6) are frequently plagued with defective, contaminated, and/or low-contrast codes. However, the powerful decoding algorithms in the image processing software of the Lector611 code reader guarantee high throughput and minimal manual rework since even defective, contaminated, or low-contrast codes can be reliably detected. Its intuitive auto-setup lets the Lector611 automatically adopt the code reading settings for both 1D and 2D codes. If codes remain unread, the cause can immediately be detected and eliminated using saved images.



Fiure 6. Material handling application.

Code identification on conveyor lines. The growth in the logistics sector has increased the requirements for process flexibility and stability. Image-based code readers or track and trace systems with matrix and line cameras enable both 1D and 2D codes to be identified on conveying systems (Figure 7). Depending on the application, the aim is to achieve the highest possible read rates at conveying speeds up to 4 meters per second. The Lector 62x can handle objects with different heights, omnidirectional barcode reading, and image output as needed for analysis software.

Figure 7. Conveyor line application

Looking ahead

Vision system technology is at the forefront of automation and digital transformation of part and product manufacturers, packagers, and distributors in multiple industries. The applications are almost limitless, and the benefits are real. Image-based code readers are another point of improvement for today's automated supply chains. Many benefits are realized in part/product manufacturing, packaging, and distribution. Advances in vision system technology are delivering a quick return on investment.

About the Author

Bryan Ferguson (bryan.ferguson@sick.com) is the market product manager of Flexible Identification at SICK. He has been with the company for nearly nine years. Ferguson is a senior-level sales executive with proven experience in business development, strategic planning, product integration, territory management, relationship building, structuring long-term corporate objectives, and expanding brand and business across diverse markets.