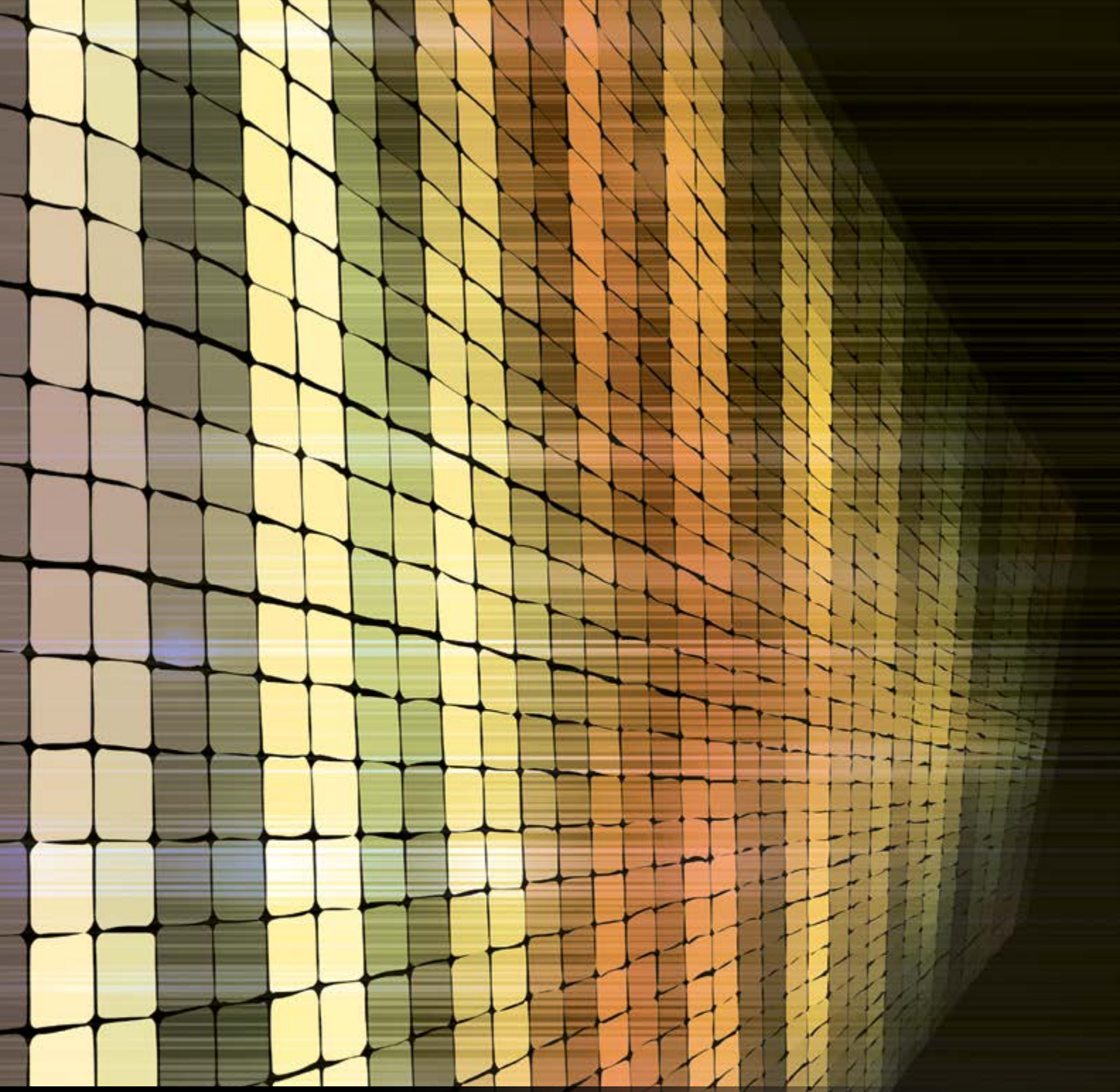


INTRODUCTION TO LINE SCAN VISION TECHNOLOGY

Image acquisition for large, cylindrical, and fast-moving parts

COGNEX

INTRODUCTION TO LINE SCAN VISION TECHNOLOGY

Image acquisition for large, cylindrical, and fast-moving parts

There are two types of acquisition methods to acquire an image of an object—area scan and line scan. The most common 2D machine vision systems use area scan cameras, which require a complete matrix of pixels to be exposed at the moment of acquisition. By contrast, line scan cameras contain a single row of pixels, building the final 2D image pixel line by pixel line.

Building a line scan image requires movement between the camera and object, usually along a conveyor belt or rotating shaft. As the objects passes in front of the camera, a new pixel line is acquired. Software on a vision processor or frame grabber stores each line, then reconstructs pixel data into the final 2D image. This unique image acquisition process excels at capturing fast-moving discrete parts on a conveyor, inspecting all sides of cylindrical objects, and building images of very large objects. Commercial devices like document scanners, photocopiers, and fax machines which scan documents into memory use line scan technology, as do production and distribution lines in manufacturing and logistics, which rely on this special technology to acquire high-resolution images quickly for detailed part inspections.

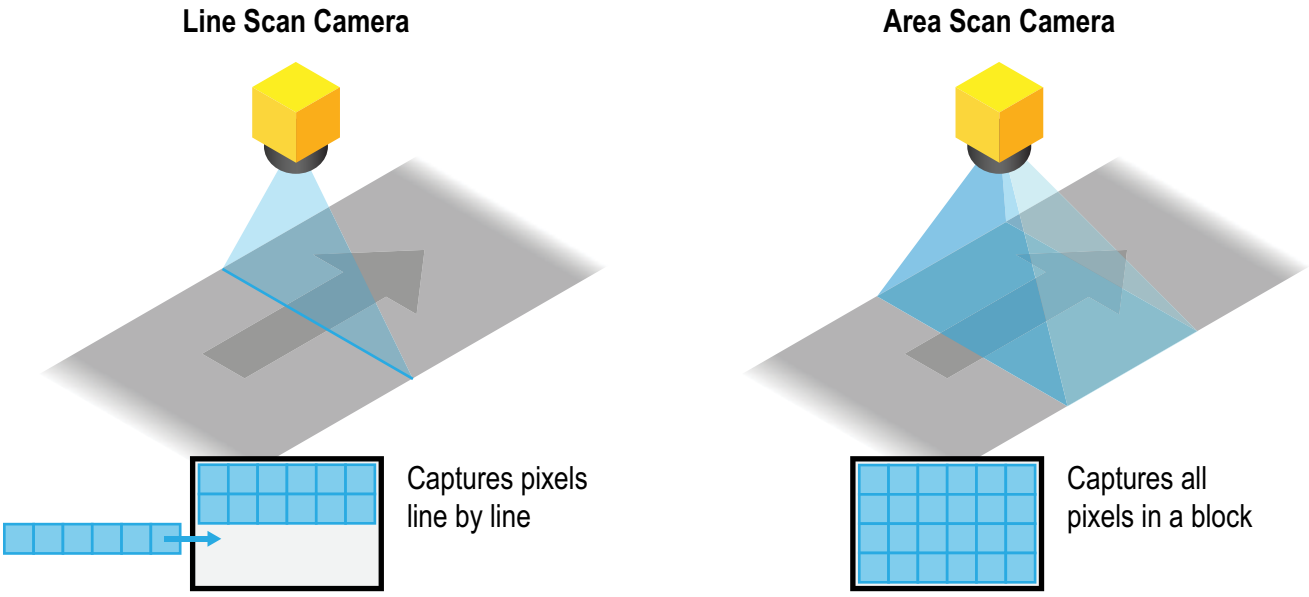


Figure 1: Area scan cameras illuminate an object and capture all exposed pixels to form an image. By contrast, line scan cameras illuminate and capture pixels line by line.

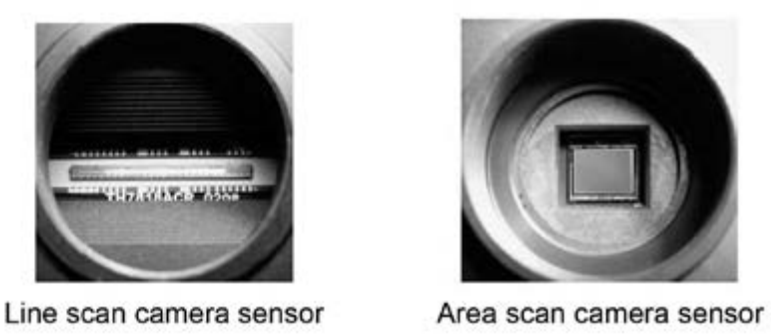


Figure 2: Imagers differ between area and line scan cameras.

With line scan imagers available from 500 to 8000 pixels per line—and some even able to match high speed line acquisition rates of 67,000 lines per second—the latest generation of line scan cameras generate all the power necessary for applications that formerly required a cluster of high-resolution vision imagers. These attributes make line scan cameras an ideal choice for capturing target objects in continuous or discrete “web” surface inspections, such as for plastic, textiles, metal, or paper. Line scan cameras can also “unwrap” cylindrical objects to capture their entire surface area. Large objects that require high-resolution imaging for precise measurement and defect detection--such as flat panel displays, solar cells, and car parts—are also well-suited to this technology. And because line scan systems only need to view a small portion of the target object for each line acquisition, they did not require a large, unobstructed view of the target object. For this reason, they work well in installations with restricted fields of view or mounting space.

Figure 3: A line scan camera unwraps the curved surface of a rotating can to capture its label without image distortion.

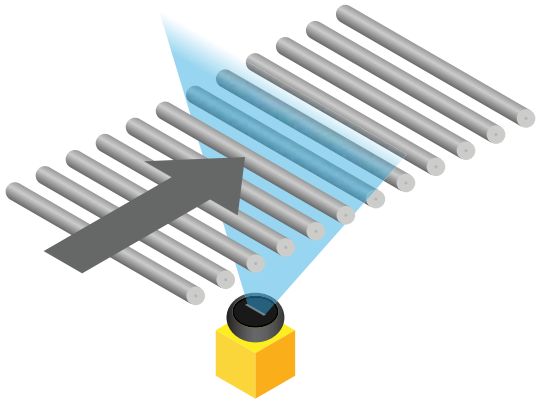


Figure 4: Line scan vision systems can successfully image objects through a narrow field of view or mounting space.

COMPONENTS

Line scan vision systems can be configured with a line scan camera and PC or vision controller running machine vision software, or as an embedded system with the camera and software contained in one package. Nevertheless, the components of these two set-ups share many elements in common. Like with all machine vision systems, selecting the correct lens, lighting, and trigger mechanism is crucial to the success of any line scan application.

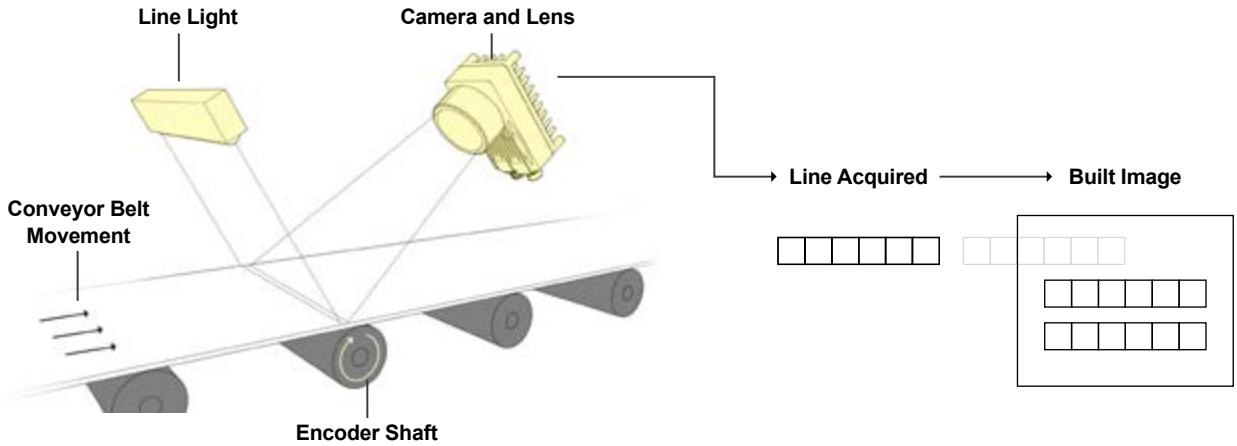


Figure 5: Lighting, lensing, encoders, and triggers are critical components of a line scan system’s configuration.

Encoder

An encoder conveys the belt's linear motion to the line scan camera, indicating when to acquire the next line for the image. In many applications, it is difficult to guarantee constant and stable movement of the moving object, especially during ramp up or ramp down of the assembly line speed. Changes in speed affect the aspect ratio of the resulting image. For example, the line scan camera could acquire lines too quickly, resulting in repeated lines and a stretched image. And if the camera acquires lines too slowly, it will skip some lines, making the image thinner. To keep a constant aspect ratio while allowing the speed to fluctuate, an encoder instructs the camera to acquire a line each time the distance traveled equals a defined value—usually the length of a projected pixel. An encoder is usually mounted on an axle and provides signals to indicate motion. Some encoders produce two separate signals (A and B), from which it is possible to detect the direction of the line and more granular information about the motion. Line scan systems can work with either hardware (motion-based) encoders or software (time-based and calculated by movement) encoders.

Line scan cameras can:

- Unwrap cylindrical objects for label inspection
- Detect printing, metal, and plastic defects and flaws
- Provide 100% inspection of very long or spooled product/part
- Provide high-resolution images for precise measurement
- Enable consistent sampling
- Support high-speed part scanning

Lighting

Line scan cameras require only a single line of light to acquire a row of pixels. This means that unlike with an area scan camera, a part does not need to be illuminated uniformly. A strong, non-fluctuating, tightly focused "line" type illumination is the most suitable in line scan applications, which also demand higher intensity light due to the fast acquisition speed (typically in the microseconds per line). The line light aligns with the camera to maximize the intensity of the light is typically always on, not strobed.

Lens

Lenses vary in optical quality and ultimately determine the resolution of a captured image. It is important to choose a high-quality lens to take full advantage of a line scan camera's pixel size. Using the right lens will help the system acquire the best possible image for finely detailed inspections.

Trigger

The trigger mechanism indicates to the camera when to begin acquiring pixels. Line scan systems can use either a hardware trigger connected directly to the camera or a software trigger issued via factory floor industrial protocol or PC.

Line scan systems have specific advantages over area scan systems:

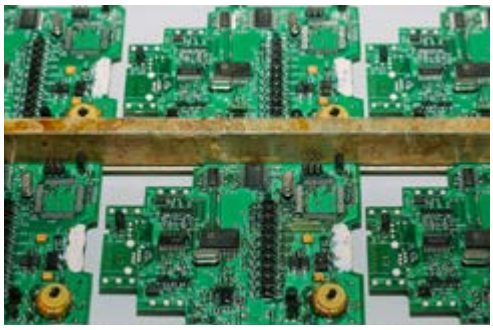
- **No fixed dimensions:** Some line scan cameras can adjust the length of the acquired image to be infinitely long. This makes it possible in certain cases to create continuous, gapless images between frames.
- **High-resolution:** It is not uncommon for line scan images to reach 80 megabytes of pixel data or more.
- **Shorter exposure time:** Area scan cameras typically require longer exposure times than line scan camera.

WHY CHOOSE LINE SCAN?

Whether for food and beverage, electronics, or packaging and logistics, line scan camera technology helps manufacturers acquire high-resolution images for fast-moving, large, and cylindrical objects that challenge area scan cameras.

Unwrap cylindrical objects for inspection

Inspecting round or cylindrical parts can require multiple area scan cameras to cover the entire part surface. A line scan camera can produce an “unwrapped” 2-D image of a cylindrical object as it spins on an axis. This avoids special fixturing and complex algorithms to stitch together several images at varying coordinate spaces. This feature is useful for inspecting the size and uniformity of objects, fill levels, labels, and safety seals



Add vision to space-constrained environments

Since a line scan camera builds an image a single pixel line at a time, it only needs to see a sliver of the object as it moves past. This attribute makes line scan cameras ideal for applications with restricted fields of view or space, such as in the electronics and pharmaceutical industries, or when the camera needs to peek through rollers on a conveyor to view the bottom of a part.

Acquire high-resolution images at low cost

Line scan systems can also generally provide much higher resolution than traditional area scan cameras. High resolution inspection is critical in most tech-oriented industries. A line scan camera with the appropriate imager can produce very large images at significantly lower cost than an area scan camera. For this reason, a line scan camera in motion is a practical replacement for a high-resolution area scan camera.

Inspect web surfaces

Since line scan systems require parts in motion to build an image, they are often well-suited for applications with products in motion, such as on high-speed packaging lines and conveyors. This makes it easy to perform long surface (or “web”) inspections and to verify codes and text. Using an area scan camera would require extra processing to reconcile frame overlaps, complicated image stitching, and hardware synchronization. Some line scan models can obtain a stream of continuous (i.e. gapless) images between frames, while others can do so with minimal gaps of a few lines. Models that perform discrete continuous inspections can take pictures of randomly-sized parts without large blank spaces between images.

THE COGNEX DIFFERENCE

Cognex offers a range of high-resolution line scan vision systems to help manufacturers and distributors meet critical inspection needs. The In-Sight 5604 and 5614 1K line scan cameras offers 1,000 x 8,000 px resolution (8,000 lines or 8MP). The new In-Sight 9902L 2K line scan camera offers 2,000 x 16,000 px resolution (16,000 lines or 32MP) in a self-contained unit, quadrupling the resolution for more detailed inspections while reducing cost and and minimizing system configuration. High-speed image acquisition (67,000 lines per second) and unique light sensitivity mode provide enhanced flexibility for a wide range of applications involving fast-moving discrete parts on conveyors, cylindrical parts, and large parts. Users also benefit from industrially rugged In-Sight hardware, powerful vision tools, and easy application development and monitoring using In-Sight Explorer software with EasyBuilder and Spreadsheet.

BUILD YOUR VISION

2D VISION

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

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-based image analysis, 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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