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Vision for Industry®

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BUYING A VISION SENSOR

10 QUESTIONS YOU MUST ASK

With so many vision sensors available today, it can be a daunting task to figure out which one is right for your particular application.

- ***Will the product you're evaluating handle the variable conditions that exist in your plant?***
- ***What are the latest networking capabilities to look for?***
- ***What types of accessories and product support options are important?***
- ***How easy is it to support your system beyond development and deployment?***

Whether you're brand new to machine vision or an experienced user, this guide will help you during your vision sensor selection process. It provides answers to ten of the most important questions to consider, and offers valuable tips on how to evaluate specific product features.

As the world leader in machine vision, Cognex Corporation is here to help you make sure your next vision project is a success. For additional information about selecting vision sensors, please contact Cognex at (877) 264-6391 or visit www.cognex.com.

**MACHINE VISION
THAT WORKS**

1. What is the importance of part location tools, and how can I assess their performance?

Part location tools, available with virtually all vision sensors, are software tools used to find parts within the vision camera's field of view. This is typically the first step in any vision application – from the simplest robot pick-and-place operation to the most complex assembly verification task – and the one that usually determines whether or not the application succeeds or fails.

While it sounds simple enough, locating parts in today's production environments can be extremely challenging for vision sensors. This is because many variable conditions exist which can alter the way a part appears to a vision sensor, which is trained to recognize parts based on a reference or "model" image of the part. Variable conditions include:

- Part rotation
- Changes in optical scale
- Inconsistent lighting conditions
- Normal variations in part appearance

VISION TIP

How can you tell if a sensor's part location tools will be able to accurately and reliably find parts under the range of conditions in your factory? On the opposite page you will find a list of the ten most problematic conditions vision sensors face, reasons why they often occur, and ways to evaluate a vision sensor's performance under each condition during evaluation.

CONDITION	POTENTIAL CAUSES	THE VISION TEST
PART ROTATION	<ul style="list-style-type: none"> • Loose part fixturing • Line movement/vibration 	<ul style="list-style-type: none"> • Rotate the part from 0 to 360 degrees
SCALE VARIATIONS	<ul style="list-style-type: none"> • Camera-to-part distance changes 	<ul style="list-style-type: none"> • Move the camera closer to, and away from, the part
BLUR	<ul style="list-style-type: none"> • Camera optics out of adjustment 	<ul style="list-style-type: none"> • Adjust the camera so the part appears out of focus
POOR CONTRAST	<ul style="list-style-type: none"> • Part blends in with background • Part has poorly defined edges 	<ul style="list-style-type: none"> • Present part against a background of a similar color
INCONSISTENT LIGHTING	<ul style="list-style-type: none"> • Inadequate or variable ambient lighting • External sunlight 	<ul style="list-style-type: none"> • Change room lighting from high to low and open and close aperture
SHADOWS	<ul style="list-style-type: none"> • Robot arm or other equipment above part 	<ul style="list-style-type: none"> • Use your hand, or another object, to cause a shadow over the part
PART OVERLAPPING	<ul style="list-style-type: none"> • Multiple, unfixtured parts moving down the line 	<ul style="list-style-type: none"> • Overlap a portion of the part with another object
REFLECTIONS	<ul style="list-style-type: none"> • Stray light bouncing off part 	<ul style="list-style-type: none"> • Shine bright light across various regions of part surface
VIBRATION	<ul style="list-style-type: none"> • Movement of conveyor belt • Motors and other production line equipment 	<ul style="list-style-type: none"> • Slightly jumble the part around under the camera
PROCESS VARIATIONS	<ul style="list-style-type: none"> • Inconsistencies in the manufacturing process 	<ul style="list-style-type: none"> • Present multiple parts that vary in appearance from process effects

2. What role do built-in network communications play, and what capabilities should I look for?

Network communications provide a number of important benefits. First, they enable vision sensors to communicate pass/fail results data to PCs at the enterprise level. Secondly, they enable vision sensors to communicate directly with PLCs, robots, and other factory automation devices.

For establishing a communication link between vision sensors and PCs at the enterprise level, make sure the vision sensor you're evaluating supports a broad range of standard network protocols, including:

- **SMTP** – SMTP (Simple Mail Transfer Protocol) capability enables e-notification of problems that occur on the production line. For example, if ten consecutive parts fail inspection, the sensor can send an email to a computer, pager, or cell phone. This not only provides emergency notification that the line may need to be stopped, but also provides a second level of inspection monitoring in situations where operators may have missed something.
- **FTP** – FTP (File Transfer Protocol) enables users to easily archive failed inspection images without writing custom software.
- **DHCP** – With DHCP (Dynamic Host Configuration Protocol), each vision sensor you link to the network is automatically assigned an IP address, enabling true plug-and-play performance. Sensors without this capability need to have an IP address manually assigned, which often involves having to ask an IT administrator for an available address.
- **DNS** – This allows you to name each vision sensor, such as "Bottling Line Sensor 1", instead of having to rely on a 9-digit IP address. Without DNS, it may be a daunting task to keep track of all the vision sensors running on the line, and often requires labels to be physically applied to each sensor with the IP address.
- **TCP/IP client/server** – This enables vision sensors to initiate the transfer of results to other devices directly over Ethernet without any code development.
- **Telnet** – An Internet standard protocol which enables remote login and connection from host devices.

For connecting vision sensors to factory automation devices such as PLCs and robots, make sure there is support for the following industrial protocols:

- **EtherNet/IP** – This protocol enables vision sensors to be linked to PLCs and other devices over a single Ethernet cable, eliminating the need for complex wiring schemes and costly network gateways.
- **ModBus/TCP** – Another factory network protocol that permits direct connectivity to other devices over Ethernet.

Finally, as more and more vision sensors are used throughout the manufacturing process, it becomes important to have a centralized way of managing them. Make sure the vision sensor you're evaluating will allow you to manage and control vision activity over the network from remote locations in the plant and beyond.

3. Does the vision sensor make it easy to set up applications, create custom operator interfaces, and administer vision sensor networks?

Vision applications don't usually require extensive runtime interfaces, but operators typically need to interact with the vision sensor in order to make modifications during part changeovers, change tolerance parameters, and determine the cause of part failures.

The vision sensor you're evaluating should allow you to create a custom operator interface as you configure the system. Make sure that this can be done without having to use Visual Basic or script-based languages.

The vision sensor should provide the tools to simplify administration and management of multiple sensors, including tasks such as backup, upgrade, and documentation.

VISION TIP

Make sure the operator interface you create can perform the following tasks:

- *Display images with graphics to allow for immediate analysis of failed parts*
- *Enable operators to easily turn the inspection on and off and modify parameters*
- *Display pass/fail results data*

4. Does the sensor have sufficient image pre-processing tools?

Image pre-processing tools allow the user to manipulate the raw image in order to highlight desired features or eliminate undesirable features. This ability can be a key factor in the overall performance of a vision sensor, and should be a part of the standard offering.

Look for products with a suite of image pre-processing tools that will enable you to provide a range of functions such as:

- Improving the contrast between the edges of a part and its background
- Filtering out extraneous or insignificant features in the image
- Eliminating reflections that have been cast off the part surface
- Smoothing rough textures in an image

By being able to optimize image data in its raw form, the overall accuracy and robustness of a vision sensor can be significantly improved.

5. What should I look for in character reading and verification capabilities?

Whether you're reading stamped alphanumeric codes on automotive parts or verifying date and lot code information on medicine bottles, there are a number of capabilities to look for when evaluating character reading and verification tools, including:

- **Statistical font training** – This capability allows you to create a single model or “reference image” from a series of images. This enables the sensor to better handle the range of normal variations in print quality it may encounter, whether it has to do with poor contrast, placement variations, degradations, or variations in stroke widths. Unless you can be positive that every label will be printed with the exact quality seen in the model, the ability to develop a statistical model can be crucial to the success of your application.
- **Image pre-processing tools** – These allow you to optimize a trained model by sharpening the edge contrast of characters and filtering out any extraneous background noise that exists in the image. Having optimized models maximizes the reliability and repeatability of the vision sensor. Please see Question 4 for more information about image pre-processing.

- **Instant image recall** – This enables line operators and technicians to quickly and easily view failed images on the monitor. Whether the failure is caused by a camera knocked out of position or a missing label, it is important to know immediately why a package failed so corrective action can be taken if necessary.

VISION TIP

In a packaging plant, package and container materials, labeling equipment, printing methods, and ambient lighting conditions are all things that can vary considerably over time. As you evaluate a vision sensor, it's a good idea to test the sensor on a large sample of good, marginal, and bad labels to understand how it holds up to variable real-world conditions.

Additionally, since characters often vary in position from label to label, it's a good idea to “open up” the region of interest around the character string. This will help you determine how reliably the vision sensor performs when dealing with a larger search region.

6. How can I determine the repeatability of a vision sensor's gauging tools?

If your application involves critical dimensional measurement, you'll want assurance that the gauging tools are not only accurate, but that they will perform with a very high degree of repeatability.

VISION TIP

Repeatability can be tested by presenting a part to the vision sensor and have it measure the part at least 25 times without changing part position, lighting, or any other variables. From this, you should be able to plot the repeatability of the measurements, and make sure that any variance in the results stays within the measurement tolerance.

In addition to testing for repeatability, it's a good idea to make sure that the vision sensor has a full suite of gauging tools. This will eliminate the need to write scripted programs to develop functions that are not part of the standard offering.

7. How do I evaluate industrial code reading tools, and what are some specific features to look for?

Today's vision sensors should offer reliable, repeatable performance on 2D codes that have been poorly formed, degraded, or those that vary in position from part to part. They should perform well no matter what type of marking method your parts are marked with (dot peen, etching, hot stamping, inkjet are among the most common methods) and on a variety of part surface types such as glass, metal, ceramic, and plastic.

VISION TIP

To evaluate industrial code reading tools, the first thing you will want to test for is the sensor's read rate, which refers to the percentage of codes the vision sensor has read out of all the codes it has "looked at." To do this, present a well-printed code to the vision sensor, and have it read the code hundreds of times under pristine conditions. Make sure the read rate is 100%, or you could face problems later. For example, a read rate of 99.7% means that one code out of every 350 is not read. At a production speed of 2000 parts per hour, the sensor could discard 2700 good parts per shift.

Once you've established the sensor's read rate, you should run a reliability test to understand how factors like line vibration, variable lighting conditions, and excessive line speeds might be affecting reading performance. To do this, present a large sample of good, bad, and marginal codes to the vision sensor. This will provide a good assessment of how the vision sensor will withstand the range of real world conditions it will need to contend with in production mode.

In terms of specific code reading features to look for in a vision sensor, you may want to ask about the following:

- **Code quality verification capability** – Look for products that can verify code quality to established standards. This can provide valuable information about how well the marking process is working.
- **Read-per-second rate** – Depending on your production line speed and throughput requirements, you may also want to verify a vision sensor's read-per-second rate. The fastest vision sensors available today can read up to approximately 50 codes per second.

- **Instant image recall** – This enables line operators and technicians to quickly and easily view failed images on the monitor. Whether the failure is caused by a camera knocked out of position or a missing label, it is important to know immediately why a package failed so corrective action can be taken if necessary.

8. What should I know about vision sensor accessories?

To ensure that your system integration process is quick and painless, look for a vision sensor with its own family of compatible accessories. This places the burden on the vendor to test each and every accessory, and confirm that everything works together without any problems. Accessories to look for include:

- **Lighting accessories** – Your vision sensor vendor should be able to offer a variety of different lighting options, since there are many different types of part surface characteristics and ambient lighting conditions to contend with. A comprehensive family of light modules should include ring light modules, which provide soft, even illumination from all directions, back light modules, which offer maximum contrast between a part and its background, dark field lights, which provide low-angle illumination for imaging of part surface irregularities, and others.
- **Communications accessories** – Make sure that communications peripherals such as I/O modules and network gateway modules are offered that will enable easy, quick connectivity between the vision sensor and PLCs, robots, and other factory automation devices and networks.
- **Monitors** – Some vision sensor vendors offer a number of sensor-compatible displays. When selecting a monitor, it is a good idea to look for an LCD display with anti-glare impact shielding, and NEMA-rated mounting bezel that provides a dust- and liquid-tight seal when mounted in an enclosure.
- **Camera enclosures** – Industrial camera enclosures offer protection from dust, high temperatures, and wash down, and should be easily mounted and able to accommodate a variety of camera lens sizes and types.

9. Does the vision sensor require a PC?

Your vendor should offer a standalone vision sensor that does not require a PC — during configuration or in production mode. The sensor should offer true plug-and-play performance that enables you to quickly configure the application, from start to finish, right out of the box. Just as important, the vision sensor should not require you to roll a PC onto the factory floor every time changes to the application need to be made. Finally, a true standalone vision sensor should enable you to hook up a monitor for live image display without a PC.

10. What types of product support services are offered?

When evaluating vision sensors, it is important to look for a vendor that offers a wide range of product support and learning services. These services start with the initial assessment of your application. Important questions to consider include:

- Is the representative assisting you a full time machine vision specialist?
- How will the application be evaluated, and by whom?
- Is the vendor willing to expend the engineering resources necessary to qualify your application, or will that responsibility be yours?
- Once selected, what product support is available for you to insure your installation is a success?
- Does the vendor offer a variety of cost effective training alternatives such as; online “self-help” support, online courses, worldwide technical support, and personalized, on-site training.
- Does the selected supplier have the track record and financial stability to maintain their role as your vision solutions provider long term?

It is also important to look for a vendor with a global network of offices offering both pre and post-sales support. This way, you can get the same consistent high level of product support anywhere in the world. This can be especially important if the system is commissioned in one location and shipped to another.

VISION TIP

Be sure that the vision vendor you work with is not merely trying to sell you a vision sensor, but rather, carefully understands your particular application and evaluates all requirements before recommending a solution. If a vision sensor is not the right solution, the company should be able to recommend another type of solution, sensor, or vision product for the job. Does the supplier offer higher end systems that can be used if the application requires it, or if your needs grow to require one?

ABOUT COGNEX

Cognex Corporation designs, develops, manufactures, and markets machine vision systems, or computers that can “see.” Cognex is the world's leader in the machine vision industry, having shipped more than 175,000 machine vision systems, representing over \$1.3 billion in cumulative revenue, since the company's founding in 1981. Cognex's Modular Vision Systems Division, headquartered in Natick, Massachusetts, specializes in machine vision systems which are used for automating the manufacture of a wide range of discrete items and for assuring their quality. Cognex's Surface Inspection Systems Division, headquartered in Alameda, California, specializes in machine vision systems which are used for inspecting the surfaces of products manufactured in a continuous fashion, such as metals, paper, and plastics. In addition to its corporate headquarters in Natick, Massachusetts, Cognex also has regional offices located throughout North America, Japan, Europe, and Southeast Asia. Visit Cognex on-line at www.cognex.com.