COGNEX vision

Expert Guide

When to choose a color vision system for your application




Introduction

Imagine only seeing the world in grayscale. So much would be hidden from view. Color opens our eyes to a world of detail. In machine vision technology detail is critical. Color imaging provides key information that impacts the quality and reliability of many types of inspections on your production line. In this Expert Guide, we will help you understand the difference between grayscale and color vision technology, which applications are best solved with color vision systems and which types of color tools are used for which applications.

Advancements for machine vision color inspection

When a vision system captures grayscale images it makes evaluation decisions based on a single grayscale value chosen among the 0-255 shades of gray. When a vision system captures color images for evaluation, it has three times more data than with grayscale images. So why wouldn't most users opt for color inspection? Historically, color image processing has been a difficult, slow and costly technique for machine vision system users.

Today, with advancements in machine vision technology, imaging processing software and inspection tools, processing color images is becoming easier, faster and less expensive. Now that color inspection is a more viable option, why and when should you think about using a color vision system?

VISION TIP

The Intersociety Color Council created a Universal Color Language, classifying colors into color spaces. These three-dimensional coordinate systems quantitatively define colors. Color machine vision primarily uses two standard color space definitions, known as RGB and HSI.

The RGB color space represents all colors as a mixture of (R)ed, (G)reen and (B)lue. RGB values are commonly described using three integers between 0 and 255, representing red, green, and blue color light intensities. By using the appropriate combination of RGB light intensities, we can create many colors between black and white.

In the other common color model, HSI space is broken down into (H)ue, (S)aturation and (I)ntensity. Hue refers to the pure color, saturation is the degree of color contrast, and intensity refers to the color brightness. Modeled on how human eyes see color, the HSI color space is sometimes considered more intuitive than RGB color model.

As seen in this table, both color spaces contain the values 0-255 in their perspective spaces. In the HSI color space it is only the hue that varies in intensity to determine red, green or blue.

COLOR	RGB	HSI
Red	255, 0, 0	0, 255, 85
Green	0, 255, 0	85, 255, 85
Blue	0, 0, 255	170, 255, 85

A comparison of RGB and HSI pixel values.

When and why to use color

Because traditional grayscale machine vision technology makes decisions based on 0-255 shades of gray, it can do an adequate job of inspecting most non-color sensitive parts. Even when parts or products have color present, the color may not be a factor in solving the inspection application. However, when the inspection focuses on parts based on color difference as when asking "Is this part the correct color?" or "Which products are orange and which are green?", grayscale machine vision technology is unreliable in many cases and, sometimes, impossible.

Manufacturers use color machine vision to solve three primary vision applications:

1. Part sortation

Color often is the only feature that differentiates parts, such as caps, containers or pharmaceutical tablets.

2. Color recognition and matching

Humans often mismatch colors, while color vision tools can reliably distinguish between them to monitor color for consistency, for example.

3. Assembly verification and inspection

Identifying that the right part has been used during assembly can be challenging when the parts are very small, or when identifying marks such as character strings or barcodes are not easily visible. In these cases, color offers an option for accurately identifying parts for determining if the part is properly assembled.

VISION TIP

16-bit color resolution allows the system to recognize 65,000 individual colors—plenty for most applications. But applications where color variations are more subtle may require more sensitive **24-bit color resolution**, which enables the system to see 16 million individual color variations...more than can be detected by the human eye.

The Color Model Tool

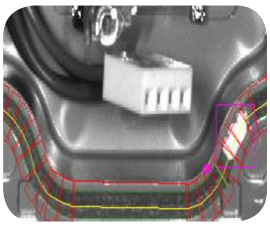
In many **consumer products**, color is the only distinguishing feature between different styles of the same product. In one example, a manufacturer wants to verify that the correct cosmetic blush color is being placed into the correct package. The blush is made up of a patchwork of different colors, making color identification challenging because some of each color appears in the other blush products. The manufacturer needs an easy way to identify the color combination as a single part color.

The Cognex Extract Color tool will consider each pixel in the selected region of interest as a color to match to each color group in the library. This tool selects and counts the matched pixels for each color group and then selects the one color group with the highest number of matched pixels as the identified color. A powerful color extraction tool should allow for a combination of colors to be extracted at the same time.

Grayscale and color machine vision application examples

Automotive

There are more than 20,000 parts in a typical automobile. The **automotive industry** uses machine vision technology to inspect many parts like brake pads, electronic components, airbags, etc.

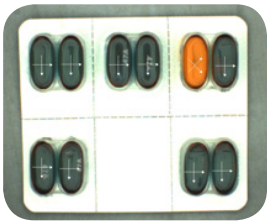


Glue application inspection

Automotive manufacturing glues are differentiated by their colors. Once only achievable by manual, human inspection, color vision technology can examine if the correct type and right amount of glue has been applied to a part. The fact that the glue bead is present or complete can likely be determined by using a standard camera, but to verify whether the correct type of glue is present will require a color vision system.

Pharmaceutical

In the **pharmaceutical industry**, products and packages are color-coded to indicate type, formulation, strength, or brand. Pharmaceutical manufacturers must perform safety inspections to ensure the proper packaging contains the right product.



Blister pack inspection

A typical color application is to inspect that blister packs contain the correct capsules. In many cases, the only differentiator is the color of the tablet or capsule. Using a color extraction tool, an entire blister pack can be inspected to see if the correct color intensity is present at the macro level. If it does not fall into the expected range, each individual blister pack can be inspected to help pinpoint where the exact problem lies.

Alternatively, if a color mixup is of no concern to your process, then a standard vision system could be used to identify the presence of all capsules in the package. A color system is not needed to inspect for missing items or to detect graphic elements on a package when color is not the distinction.

The Color Tool

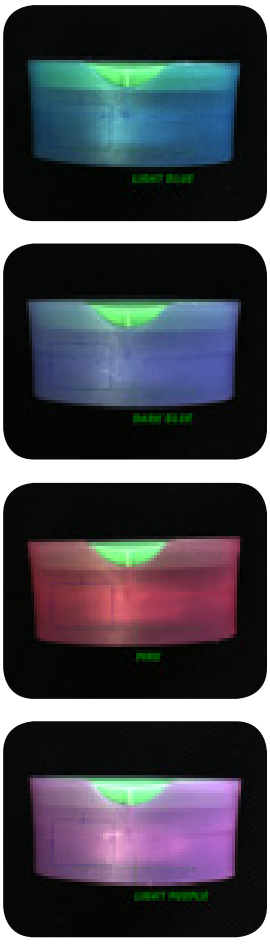
The Cognex Match Color tool averages all the color pixels in the selected region of interest, compares it to the trained colors in the library, computes the difference between them and selects the one with the lowest difference as the identified color. Match Color is best for color sorting or color monitoring applications that rely on looking at one color at a time. This tool ensures an accurate color match between components used in the same product while interpreting subtle color differences. In the white color family, for example, shades might include white, off-white, champagne, pearl and cream.

Food and Beverage

In the **food and beverage** industry, color plays a strong role as it is often a reliable indication of freshness, proper processing, or packaging verification.

As an example, four different color caps represent four different products or flavors. A manufacturer would need to identify that the proper color is present before placing it on the bottle. Although the colors are different, some look very similar, so high accuracy color identification is needed for product safety concerns.

In contrast, if the only inspection task is to verify that the caps are facing the right way, a grayscale vision system could validate the orientation of the cap before placement.



Color product cap inspection

In-Sight 7010 Entry-Level Color Vision System

The In-Sight® 7010C is an entry-level 24-bit color vision system that can distinguish parts by color. Thanks to the intuitive EasyBuilder® interface, even the novice user can deploy the powerful Cognex vision tools available in the In-Sight 7010C, including pattern finding and measurement as well as color identification.

Like the existing suite of In-Sight 7000 vision systems, the color models have cost-saving features that simplify integration, including:

- Compact, IP67-rated housing
- Autofocus technology
- Integrated lighting options
- Robust factory communications capabilities

www.cognex.com/IS7010

Summary

As these examples illustrate, capturing color images significantly improves the flexibility and performance of machine visions applications for color verification, matching, sorting and inspection applications. Today's color vision tools have come a long way in precision, reliability and ease of use, making color vision systems a practical and cost-effective option for improving manufacturing performance.

To learn more about color machine vision tools and cameras from Cognex, please visit www.cognex.com/color or contact a Cognex representative.

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