



White Paper

Color inspection made easy.

Background information on color inspection setup

When it comes to color inspection tasks in industrial image processing, color measurement is usually not in the first place – in particular where deploying rather favorably priced vision sensors. Instead, it is more about making sure the right color is in the right place respectively present at the targeted object. Color in the form of a 3D parameter is rather complicated, and an easy solution for color differentiation used to be hard to find. The present white paper seeks to give answers by taking color inspection setup with *VeriSens*[®] vision sensors for an example.

Table of content

1	Introduction	3
2	The complexity of color in image processing	3
2.1	Why is the color parameter that complicated?	3
2.2	The effect of color tolerances	3
2.3	The indispensable white balance	3
3	Color inspection made easy to everyone: the innovative approach	4
3.1	Rather than technology, the application takes center stage	4
3.2	Fine-tuning for optimum results	4
4	Summary	5
5	Author	6

1 Introduction

In every-day industry routine, color-relevant applications are manifold and range from verifying whether the correct wire color is assigned to the terminal on to color luminescent LED assembly over to lid color inspection in bottling installations. But when going deeper into the color topic, things will soon turn out complicated. A simple and cost-efficient solution for color inspection is much sought after – all the more when it comes to vision sensors.

2 The complexity of color in image processing

2.1 Why is the color parameter that complicated?

Industrial image processing usually does not fully exploit the optical information supplied. Many applications leave color aside unless becoming absolutely necessary. Color information provides many benefits – among others, it allows for clear differentiation of similar objects. So, why is color the poor relation in many applications?

Contour and greyscale-based image processing utilize one respectively two-dimensional parameters, such as grayscale, number, position, etc. while the user interface acts as a sort of slider. One slider for example defines that there must not be more than three objects. Two sliders set a minimum and maximum limit and allow for corresponding feature check. However, the parameter “color” does not enable easy solutions by slider or another one-dimensional graphic user interface (GUI). Why? Seeing colors is a perception – a sense only enabled by special anatomical building blocks. Daylight provides our brain with

additional information on hue and saturation. For color mapping by color models, human eyesight and perception were “standardized” in test groups and statistics. The so-called HSV color model (hue, saturation, value) is mapping color in an analog way by brightness, hue, saturation and value (in relation to brightness). The well-known RGB color model is different, but none can do without a third dimension. A slider however is unable to handle three-dimensional color parameters. To find ways round, often three dual sliders or similar GUI elements are utilized in parallel to enable maximum and minimum limits in each color dimension, which calls for 6 limits per color.

2.2 The effect of color tolerances

An image processing system requires clear values to ensure precise results. To differentiate between two colors, it takes more than just 2×6 limits – furthermore, any intersections within the 3D color space must be eliminated. Inadequate limits may cause identification errors in later color inspection. In the worst case, a wrong color is misallocated to the defined targeted color – a “NOK” object would be identified “OK”. Even worse, object surface mapping is usually non-homogeneous due to reflections by surface properties, shape and illumination, making it all even more complex and prone to errors.

2.3 The indispensable white balance

One step is indispensable prior to color inspection: the white balance. Unlike a camera, the human eye is capable of chromatic adaption which can be seen as white balance operation that runs fully automatically. Even at a different color temperature of light, a white paper will be recognized as white. Before having completed the white balance, object colors often come with a specific “cast”. The prevailing on-site illumination will most likely differ from any color cast configured by default

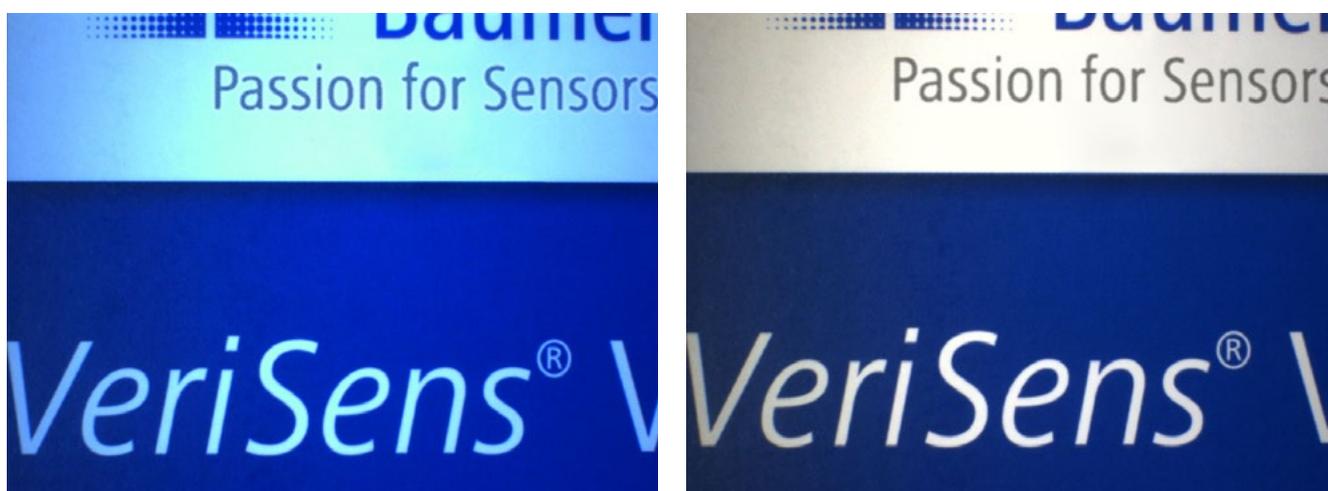


Fig. 1: White balance (left: before, right: after)

for example LED illumination may cause a rather strong bluish cast in the image. Ideally, the image processing system will perform the white balance with just a mouse click using a white surface or a color grey chart. After the white balance operation, the surface appears in white which is an achromatic color and any cast in the image has been eliminated. Now the image processing system is ready for configuration.

3 Color inspection made easy to everyone: the innovative approach

3.1 Rather than technology, the application takes center stage

In industrial image processing, complex configuration and the entailed high error potential are some reasons for leaving the color parameter aside where possible. All the more so when it comes to vision sensors, here the user will be hardly willing to become familiar with color theory.

With *VeriSens*[®], the intuitive vision sensor, Baumer succeeded in overcoming the obstacles in color inspection setup. To the user for example, the only thing that matters in the application is differentiating between "orange" and "brown" respectively to make sure the orange object is not in the place of the brown one. This not only calls for clear identification of color and position, but any color intersections must be eliminated in parallel. In the example of orange and brown, already the level of brightness may hamper correct color identification.

You rather would say "orange" and "brown" than speaking of "color space dimensions". That's where the *VeriSens*[®] sensors pick up the user right at color teach-in: Color teaching runs intelligently and in a three-dimensional way in the system background, while in parallel the color name is allocated from a defined palette of colors (list of colors present in the sensing range). After the teaching operation, a color sphere with tolerance delta E is mapping color and its tolerance, each defined at a specific point in the color coordinate system and allowing for reduction by one tolerance each. This is the only step to get the system ready to start.

3.2 Fine-tuning for optimum results

Back to our example of "orange" and "brown". Within the 3D color space (L*a*b) these colors are very close. To ensure yet precise differentiation, *VeriSens*[®] provides an innovative approach for unrivalled easy setup of color inspection. The taught-in colors may be that similar they have intersections. In this case, the "palette of colors" will give a warning, since unambiguous color

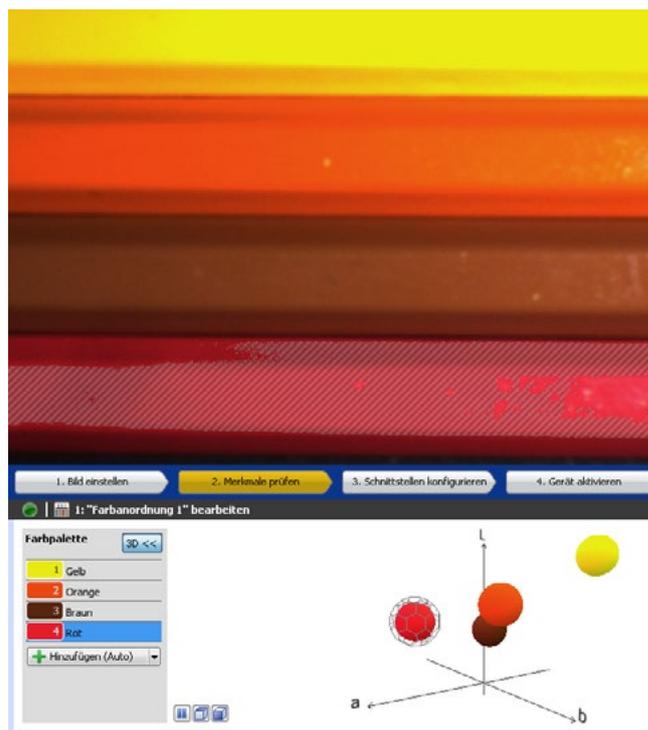


Fig. 2: Example of „orange“ and „brown“

inspection for this object is not ensured. As an option, the user may change to interactive 3D view mode. Similar to a planetary system, the color spheres appear in a 3D universe which allows for monitoring of potential intersections and direct intervention to reduce the tolerance where required. The narrower the color tolerance, the smaller the sphere. This has an effect on the target color area of the object: if tolerances are tight, the pixels outside the limits will not be allocated to the taught-in color. In the same way, too narrow tolerances together with irregularities on the object surface may impair color identification. For this reason the tolerance should for example not be inferior to 5.

Vice-versa, a tolerance that is too high will have pixels of other colors being allocated to the target color which will also result in identification errors. Therefore, teaching every color that is present (even those to be eliminated) is important in color inspection tasks to reveal any potential intersections with the target color within the color space.

4 Summary

In industry practice, color-based applications are a complex topic due to very specific color properties. *VeriSens*[®] vision sensors are an easy and cost-efficient approach in color inspection. The user only needs to define 1 limit instead of the previously required 6 ones. The critical point of unambiguous color identification has been overcome by an easy and intuitive solution and allows the user to fully exploit the benefits he is offered by the parameter "color".

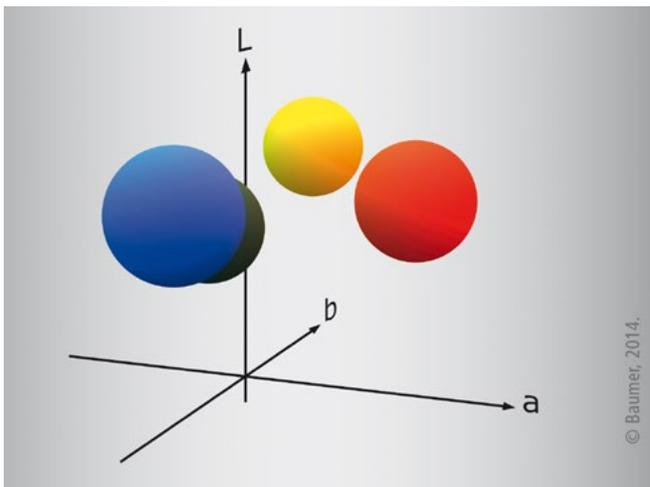


Fig. 3: The principle of color mapping by *VeriSens*[®] vision sensors is based on spheres; the radius of each represents the defined color tolerance.

5 Author



Michael Steinicke
Product Management

Baumer Optronic GmbH
Badstrasse 30
DE-01454 Radeberg
Phone +49 3528 4386 0
Fax +49 3528 4386 86

Baumer Group

The Baumer Group is an international leading manufacturer and developer of sensors, encoders, measuring instruments and components for automated image-processing. Baumer combines innovative technology and customer-oriented service into intelligent solutions for factory and process automation and offers a uniquely wide range of related products and technologies. With around 2,300 employees and 38 subsidiaries and in 19 countries, the family-owned company is always close to the customer. Industrial clients in many sectors gain vital advantages and measurable added value from the worldwide consistency of Baumer's high quality standards and its considerable innovative potential. For further information, visit www.baumer.com on the internet.



Schweiz
Baumer Electric AG
P.O. Box
Hummelstrasse 17
CH-8501 Frauenfeld
Phone +41 52 728 1122
Fax +41 52 728 1144
sales.ch@baumer.com

Deutschland / Österreich
Baumer GmbH
Pfungstweide 28
DE-61169 Friedberg
Phone +49 60 31 60 07-0
Fax +49 60 31 60 07-70
sales.de@baumer.com