SalesNote

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colorSENSOR CFO100
Sales arguments in comparison with Keyence

With the colorSENSOR CFO100/CFO200, Micro-Epsilon Eltrotec has launched a very modern and powerful sensor. A competitive product to the CFO100 is the color sensor CZ-V21 AP from Keyence. In order to make a meaningful comparison between the two sensors, we performed extensive test measurements and prepared and investigation report. This SalesNote summarizes the most important results from the investigation report and provides you with some sales arguments.

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Subject of investigation

In order to achieve a neutral comparison of both products, we performed three distinction tasks from everyday industry. Aspects of investigation are accuracy and handling. As identical as possible settings and testing environments are chosen. Before every new test setup, each sensor is reset to factory settings and recalibrated.

1. Distinction of RAL colors
RAL colors are used wherever surfaces are painted. In the first run, we test if the two CZ-V21AP and CFO100 color sensors are able to distinguish two red, two white and two green color shades from the RAL K1 and RAL K5 color fans with a color distance of ΔEabs 3.21; 6.90 and 6.06 respectively.
Both sensors are suitable for this task.

2. Material color of metallic measurement objects
In industrial applications, it's not only the basic colors of products but also the materials and coatings which must be recognized and distinguished. Here, color sensors are an advantageous solution. Usually, shiny-metallic surfaces present a challenge to color sensors. This is why we test in a second attempt if the two color sensors each distinguish three screw nuts with different coating or material (zinc, stainless steel and brass). As the individual surfaces are not homogeneous, this results in a color variation of 1.0 – 12.9.

In order to detect this large range, you have to adapt the tolerance range for color recognition with the Keyence CZ-V21AP in such a way that all inhomogeneous sides of a screw nut type can be assigned correctly. This causes the recognition values to overlap which makes it impossible to clearly distinguish the different parts. *This is why the sensor from Keyence is not suitable for this measurement task.*

The colorSENSOR CFO100 here offers the advantage that the multi-teach function enables to combine several colors in one color group. This increases the color recognition accuracy. The three screw nut types for the colorSENSOR CFO100 are in different color locations. The Delta E values between the screw nut types determined during the test have an average > 9.8.
The CFO100 color sensor can unambiguously assign all frontal surfaces of the correct screw nut type and thus distinguish the screw nut types.

3. Test setup (C) PDC parking sensors

In the automotive industry, the car color and the painted attachments manufactured by different suppliers have to be correctly assigned in terms of their color. Once the attachments are assembled in the car, one will immediately recognize the slightest of color deviations. This is why the individual components have to be painted with the correct color during production and no optical deviations must be visible. The difficulty with components in the automotive industry lies in the large number of different surfaces and shiny or metallic paintings. Often, very similar colors have to be distinguished.

Therefore, we check in the third attempt if the paint colors can be recognized. Two differently painted parking sensors (PDC) with and without metallic effects are the subject of investigation.

The following colors were tested:
Reflex silver (19), Silver leaf (21), Maritime blue (6),
Shadow blue (15), Fluid brown (14) und Wheat beige (22).

Although the CZ-V21AP from Keyence can distinguish the silver colors 19 and 21, it cannot differentiate the other colors even after having adapted the detection threshold. For example, there is a minor color distance of $\Delta E_{rel} < 5$ between the two colors PDC 14 and 22 which cannot be evaluated reliably by the sensor.

The specified color distinction accuracy (color distance) of the colorSENSOR CFO100 is $\Delta E_{rel} \geq 1.0$. Since the determined relative color distance ΔE_{rel} between PDC 14 (fluid brown) and PDC 22 (wheat beige) is ≤ 0.6, it's not possible to distinguish the distance reliably.

The other colors have a color distance of $\Delta E_{rel} > 4$ and can be reliably distinguished by the CFO100.

Summary

The CZ-V21AP enables to distinguish the RAL color samples on paper and the light silver metallic PDCs.
The colorSENSOR CFO100 reliably distinguishes almost any sample tested. It only has difficulties when distinguishing the beige silver metallic PDCs (14 vs. 22)
The following table again shows the recognition performance in all three applications tested and whether the distinction was successful or not.

	ΔE_{rel}	Keyence CZ-V21	CFO100
RAL3001 / RAL3002	1.8	✓	✓
RAL6027 / RAL6034	6.8	✓	✓
RAL1013 / RAL1015	6.2	✓	✓
Zinc / Stainless steel	9.8	✗	✓
Zinc / Brass	13.9	✗	✓
Stainless steel / Brass	22.5	✗	✓
PDC 19 / 21 Light Silver Metallic	7.5	✓	✓
PDC 6 / 15 Dark Blue Metallic	4.4	✗	✓
PDC 14 / 22 Beige Silver Metallic	0.6	✗	✗

Rating Keyence CZ-V21AP

- Reliably distinguishes diffuse reflecting colors in paper printing
- Difficulties occur with the distinction of strongly reflecting/shiny and metallic surfaces
- Lower repeatability/measurement accuracy
- Limited functional range (only expansion of tolerance threshold)
- Limited choice of sensor heads

Arguments for Micro-Epsilon colorSENSOR CFO100

- All samples are detected reliably (except for the samples PDC 14 and 22 silver metallic)
- Particularly noteworthy is the reliable detection of shiny metallic surfaces
- Increase of recognition accuracy and process reliability due to multi-teach function
- Simple and intuitive operation via the web-based interface implemented in the controller
- Due to the integrated evaluation unit, the customer receives a good/bad result which is immediately visible.

Recommendation

For metallic and shiny surfaces, we recommend you perform the measurement at an angle of 45°/0°.
The corresponding sensor head is available for the colorSENSOR CFO, but not for the Keyence CZ-V21AP.

Comparison of technical data

Manufacturer	Keyence	Micro-Epsilon
Description	Keyence CZ-V21AP with CZ-H32	CFO100
Photo		
Color distance	n/a (> 1.5)	ΔE ≥ 1.0
Color spaces	Super I, C, C+I (RGB)	XYZ, xyY, Lab, Luv, u'v'L
Distance models	Sphere	ΔE (sphere); cylinder; box
Averaging	n/a	Moving via max. 200 values
Size of color memory	8 (2x4) Display reference channel: 1 (display)	max. 256 in 6 groups Display reference channel: max. 256 (web interface)
Switching frequency	max. 5 kHz (high speed)	10 kHz
Repeatability	n/a	ΔE ≤ 0.5
Outputs	4 control outputs PNP open collector max. 30 VDC	3 digital (GND/+UB), NPN, PNP, PushPull, INV.
Interface	-	Ethernet; RS232
Software	-	ME web interface
Protection class	IP40	IP65
Features	- Adjustment of sensitivity via calibration input - Vibrations up to 55 Hz - Series connection with 4 sensors - DIN rail mounting	- Multi-teach function and grouping - Modern and simple web user interface - High color accuracy and repeatability - Currently brightest illumination in this class - DIN rail mounting possible