MATRIX OR LINE SCAN CAMERA? CHOOSING THE RIGHT CAMERA FOR YOUR REQUIREMENTS

BY SÖREN SPRINGMANN

The market for print image inspection systems is in flux. While the previous division was essentially based on low-cost observation systems and high-priced automatic inspection systems, this differentiation has become increasingly blurred in recent years. Even simple web inspection systems now offer rudimentary automatic inspections. But despite all the technical advancements in these devices, they cannot match the performance of classic inspection systems. The low-cost matrix cameras installed set narrow limits on the possible inspection performance. Even today, there is no way around the much more complex line-scan camera systems for a complete print image inspection. A look at the properties of the respective systems can explain why this is the case.

We encounter matrix cameras every day. They are in consumer devices such as cameras, telephones, and webcams - and thus ubiquitous. In contrast, line scan cameras are rarely found in consumer products but are mainly used in industrial applications such as measurement, sorting, and quality assurance.

A matrix camera takes a picture of a large rectangular area that can be displayed directly on a monitor. Example: A 12-megapixel camera takes a picture consisting of 4000 pixels across the direction of travel and 3000 pixels in the direction of travel in a single shot. Because of the 4000 pixels, such a system is also called a 4k system.

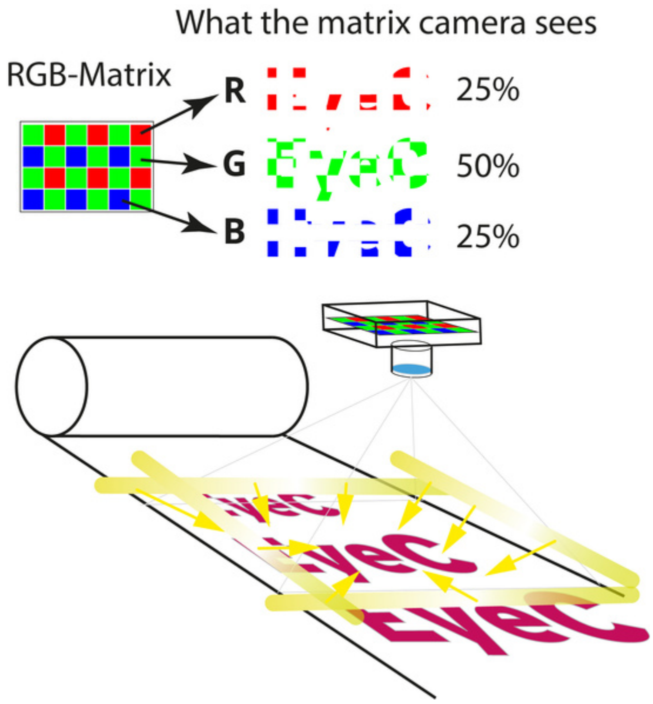

Figure 1:
Matrix camera view

In contrast, a 4k line scan camera also takes an image with 4000 pixels across the direction of travel – but it only has one pixel in the direction of travel and thus depicts significantly less than one millimeter of the web. To obtain a 12-megapixel image, the line scan camera must take 3000 individual shots and then combine them into one image. A great effort, but one that is reflected in tangible advantages within the inspection performance.

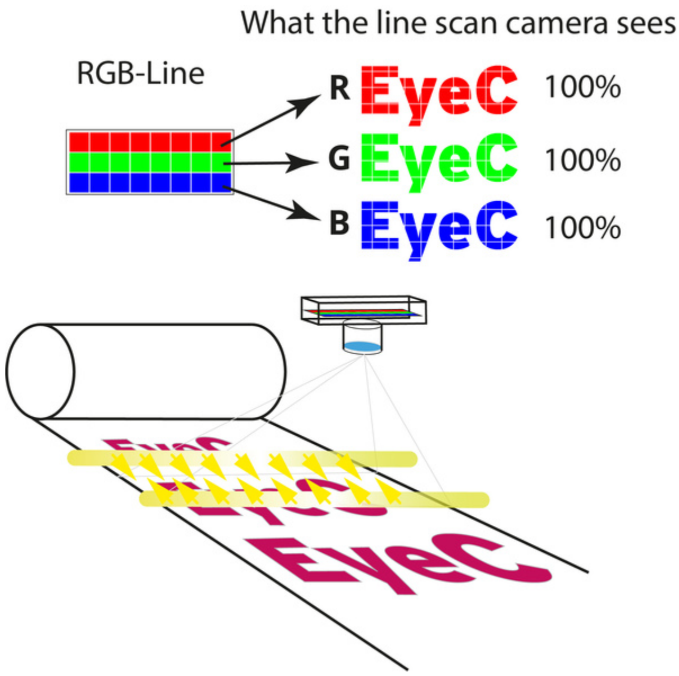

Figure 2:
Line scan camera view

SO, WHAT MAKES THE COLOR LINE SCAN SO MUCH BETTER?

The answer can be found by looking at the heart of the camera, the so-called sensor. The color line sensor is a long, slim strip of highly purified silicon with three side-by-side thin rows of many pixels, divided into the three primary colors red, green, and blue. In a 4k sensor, for example, there is one row each of 4000 red, 4000 blue, and 4000 green pixels. As the print web passes under the camera, an image is built up line by line that has complete RGB information at each location.

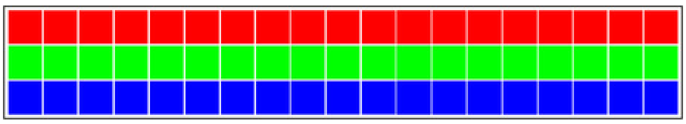

Figure 3:
Trilinear line senor

In contrast, a color matrix sensor has a rectangular, light-sensitive surface consisting of thousands of pixels arranged in columns and rows. To obtain the three primary colors red, green, and blue, each pixel has its own color filter. This arrangement is called the "Bayer pattern" and specifies that half of the pixels have a green filter and one-quarter of each pixel has a red or blue filter. The color matrix camera can therefore not determine a red, a green and a blue value for each pixel, but provides only one of the color values - never all three.

Ergo: A matrix camera only sees ¼ of the color information, while a line scan camera always sees 100%, as shown in Figure 5.

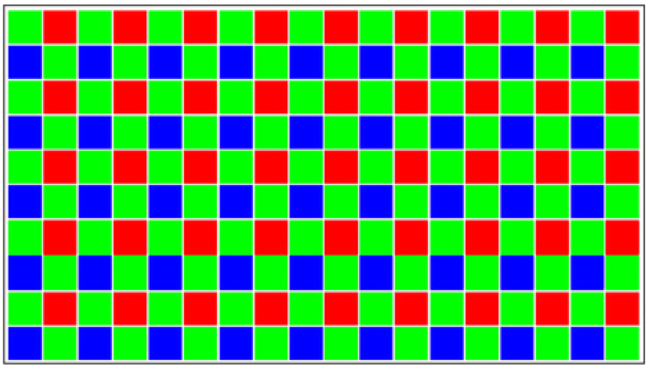

Figure 4:
Colour sensor matrix camera

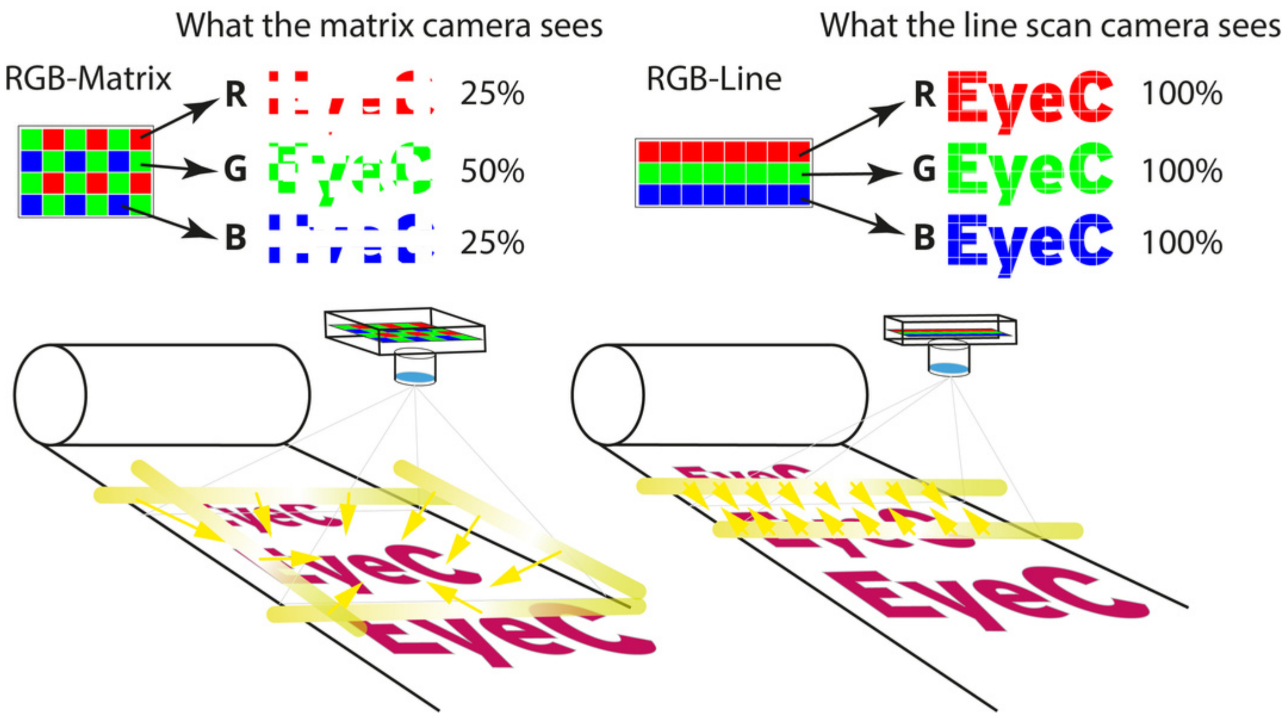

Figure 5:
Matrix and line scan camera comparison

If one only wants to have an appealing photo, this procedure poses no problem. Clever algorithms in the cameras guess the probable color information based on the respective neighboring pixels and supplement it accordingly. Of course, a real measurement is not possible with this guessed image content. For print image control, this means that the matrix camera can show coarse deviations. However, for all structures smaller than four pixels, the matrix camera cannot make any statement about the color of the object.

However, to ensure that even small colored structures are printed cleanly on each individual product, we need an image with complete correct color information in each pixel. Such an image is provided by the line scan camera. By controlling 100% green, 100% red, and 100% blue, the line scan camera provides three times as much information at nominally the same resolution as the matrix camera.

In other words, 2k color line scan cameras are just as powerful as 12-megapixel "4k" color matrix cameras.

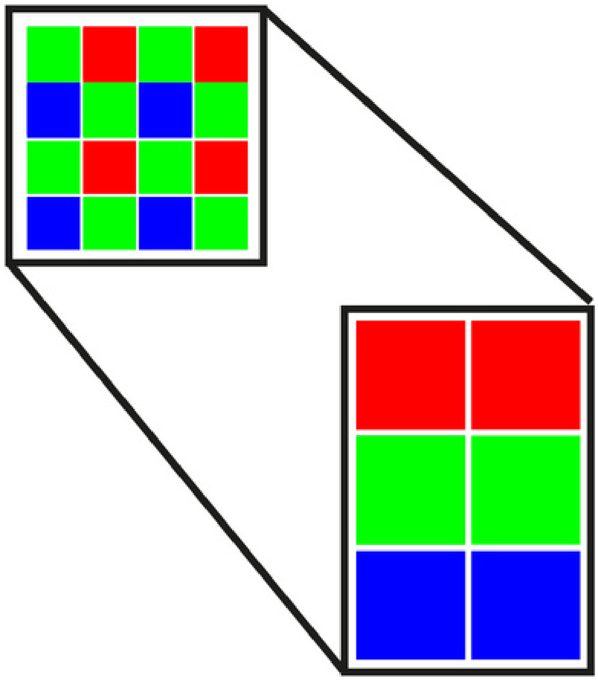

Figure 6:
Comparison: while a matrix camera requires 16 individual pixels, a line scan camera only requires 6 pixels

Another disadvantage of matrix cameras is the difficult illumination. To get a uniform inspection result, we need good, homogeneous illumination of our field of view. Of course, the lighting must not obscure the print image and can therefore only be positioned quite far from the observation point. In addition, the different illumination direction at each location makes it impossible to reliably inspect glossy materials such as holograms or metal foil applications. The inspection of embossed cardboard, lacquered surfaces and other demanding materials is also a major hurdle for matrix systems. In contrast, line scan cameras offer a simple solution. Their field of view is a narrow strip perpendicular to the web, allowing optimal illumination from all possible angles. This provides an easy-to-use, full-area inspection option, even for glossy and complex materials.

SO WHY, WITH ALL THESE DIFFICULTIES, ARE MATRIX CAMERA-BASED SYSTEMS STILL OFFERED FOR PRINT IMAGE CONTROL?

The answer lies in the price. Despite their limitations, matrix camera-based systems are still a good option for less demanding applications and are a cost-effective solution for printers. If printed products are not colorful and not glossy, they can be inspected with matrix systems despite the limitations mentioned.

For more demanding print products, however, there is no way around the line scan camera. This is because color, gloss, embossing or holograms can only be inspected effectively with line-scan camera systems, as they offer optimum conditions for uniform illumination and maximum sharpness. In this way, line scan cameras allow reliable, reproducible inspection results for the entire range of printed products.

CONCLUSION

Both systems have their justification on the market. However, it is generally very easy to identify the concept that is best suited to the task at hand. Matrix systems are much cheaper and cover the requirement profile of simple, less refined print products.

As soon as color, gloss and small structures must be inspected and a high reproducibility of the inspection result is required, we need line scan cameras.

Line scan cameras are therefore a must for printed products in the pharmaceutical industry and for brand manufacturers. But complex surfaces such as glossy, metalized surfaces, lacquering or film lamination are also found in all other areas.

A line-scan camera system is needed to ensure a real 100% inspection and solid quality assurance for these products.

GOT ANY QUESTIONS ?

Email us at **info@EyeC.com**