

# 12-bit dynamics

## Applications in machine vision

*The once huge difference in speed or frame rate between digital 8 and 12-bit camera systems has now vanished due to continuous improvements in image sensor manufacturing and microprocessors. What is left is simply a certain price difference and the question of whether 12-bit camera systems can be used for machine vision and if so, the criteria defining these applications.*

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*The compact 12-bit camera system used in the application described.*

In general it can be said that 12-bit, as opposed to 8-bit camera systems, do not have adjustable gain stages because the image sensor dynamic makes them superfluous. Furthermore, their overall image quality is superior, due to better linearity, less cross-talk and less jitter in the timing of the image sensors and their circuits.

Presumably, this is due to the more exacting image quality requirements imposed on the 12-bit camera systems used for earlier applications. Furthermore, advances in semiconductor technology have reduced the cost of manufacturing these camera systems and so increased their appeal for industrial applications.

### Inspection of glass containers

The most important parameters in machine vision applications are the time it takes to detect and analyse an image and to trigger a reaction or a decision and the

quality of the decision, which will depend on the aforementioned process. This is considered below in the light of an application kindly provided by Krones AG ([www.krones.de](http://www.krones.de)). Nowadays, when factors such as recycling, sustainability and economic efficiency count for a lot, the inspection of glass containers and of bottles in particular, tends to attract considerable attention.

Used bottles have to be checked for intactness before they are used. This test has to strike a balance between the consumer's interest in a maximum number of intact bottles and the manufacturer's interest in maximizing bottle output. A certain throughput speed is also needed (up to 18.3 bottles/s). The inspection tolerances are therefore narrow and double exposure, i.e. one exposure to determine the optimum settings and one for measurement, is not possible. Furthermore, exposure control cannot be adapted from

bottle to bottle, because of the high variance in transmission that may occur within a single series of bottles.

The parameters required for the inspection of each bottle are: bottom inspection, bottom stress, sealing surface inspection, residual liquid control, side wall inspection, orifice or thread inspection and false bottle detection. It should be possible to evaluate these parameters on bottles and jars of varying shapes and transparencies. The different shapes and colours pose a special challenge.

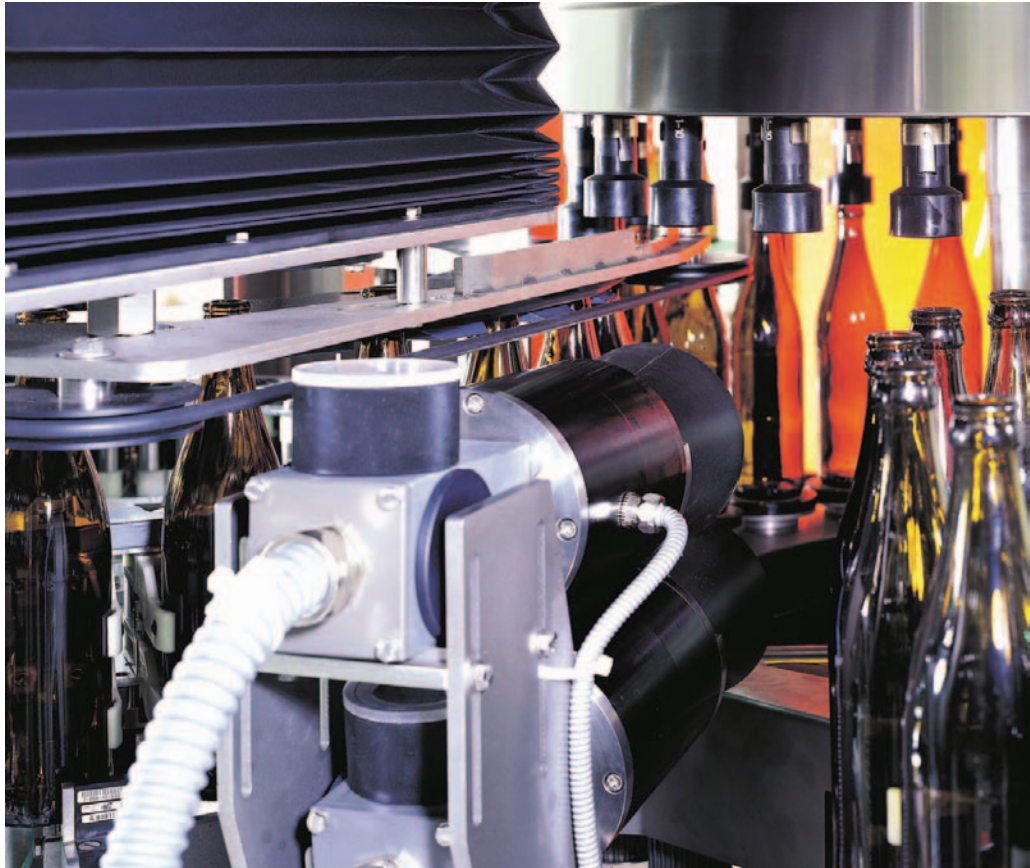
### Two alternative solutions

There are two alternative solutions to this problem. First, the separate measurement of transmission before real image uptake followed by the adaptation of the light source control and exposure using an 8-bit camera system. Here, there is a risk that high-contrast bottles and jars, such as strongly curved

bottles, will not provide sufficient information for proper processing. The other alternative is that used by Kronos for various applications. This system works with adjusted constant light sources and standard exposure using a 12-bit camera system, the dynamic range of which means that it can cope with every glass imaging eventuality.

Here it is sufficient to record just one image. With 4096 (12-bit) instead of 256 grey levels (8-bit), each area of interest can be scaled to facilitate proper image processing. For the imaging of moving objects it is necessary to keep exposure times as short as possible, which in turn necessitates high levels of illumination. Another feature of 12-bit image sensors proves advantageous in this connection. In general, 12-bit image sensors are more sensitive (higher quantum efficiency) than 8-bit sensors. As mentioned above, transmission values can differ up to a factor of 50 within a single series of bottles. With the 12-bit dynamic, appropriate image processing and hence the necessary throughput speed are no problem at all.

As mentioned earlier, 12-bit camera systems are more expensive than 8-bit systems, but they also provide more information. At the

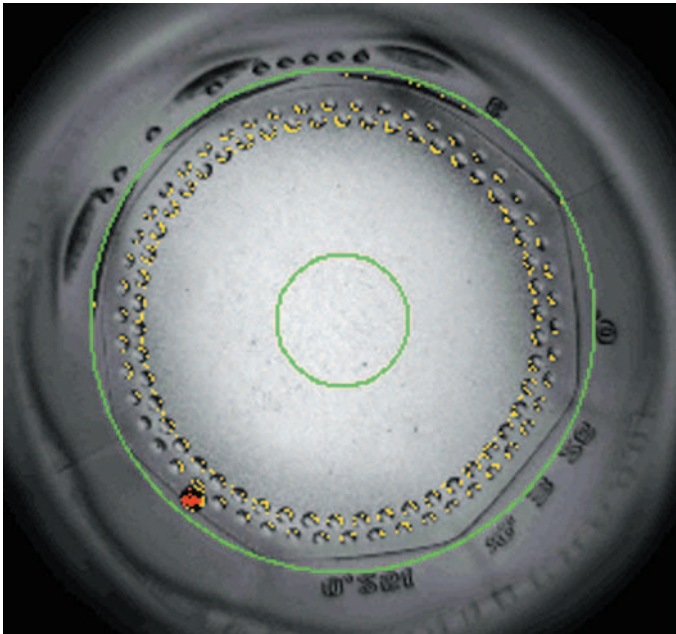


View of the camera and bottle transport inside an inspection machine.

same time there is no need for complex gain controls and expensive illumination set-ups. In view of the costs, the integration of a 12-bit

camera system may turn out to be more efficient than the use of an 8-bit system. Therefore, in quality control in particular there are plenty

of reasonable applications for 12-bit camera systems, which in turn answers the question posed right at the beginning of this article.



Resulting image of a bottle for a shape check with overlaid detection graphics produced by the image processing software.



Resulting image with test contamination spots and overlaid detection graphics produced by the image processing software.