Efficient Food Manufacturing Enabled by Prism Cameras

Interview with James Cameron, Sales Director EMEA at JAI

To ensure the nutrition of the steadily growing world's population, increasing automation of processes is required in many areas of the food industry. Powerful machine vision systems play a crucial role in optical quality control in this environment. James Cameron, Sales Director EMEA at JAI, explains the requirements and solutions for the food industry.

inspect: How has the food industry evolved with machine vision and what are the trends for the next years?

James Cameron: Over the past five years, machine vision in the food industry has evolved from a static inspection tool into a more intelligent system to secure quality-assurance and even predict data. In the fruit sector, deep learning and multispectral imaging are becoming more standard to detect outside surface defects together with internal defects, resulting in reliable grading, fewer false rejects, and the ability to estimate internal quality factors like sugar content or bruising non-destructively.

The shift to edge processing and embedded AI has allowed real-time decisions directly on the production line, improving consistency and reducing waste. Over the next years, the focus will shift increasingly toward predictive vision systems. Deep learning models will not only classify defects but forecast freshness, ripeness, and shelf life. We'll also see growing use of 3D and laser-based imaging for precise localization and robotic handling for packaged goods.

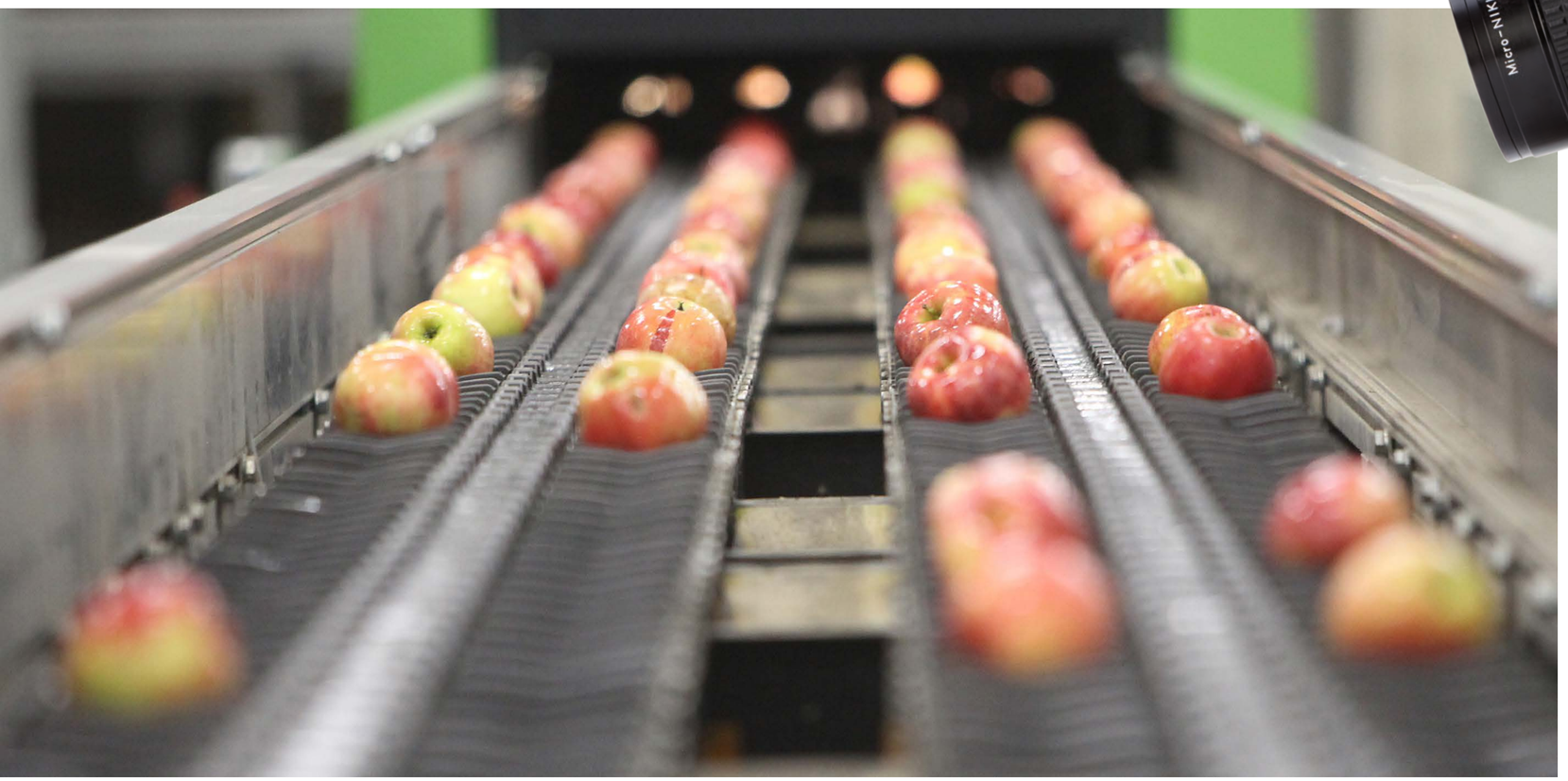
» One of the main issues in the food industry is to increase inspection efficiency and end-quality when grading and sorting food items.

Future growth will come from modular and customized vision platforms with optical lane sorters and free-fall sorters to adopt customer needs. These systems will connect inspection data across the entire value chain to packaging making machine vision one of the key enablers for efficient and waste-reduced food manufacturing. The optical sorter vision market is already large and growing double digits, signifying the critical role of vision adoption for the food industry.

inspect: What are the special demands for machine vision in the food industry?

Cameron: In the optical sorting industry, fresh fruit is typically inspected while transported through cups or lanes, allowing each product to be stabilized for precise surface and color analysis. Whereas vegetables, grains, and rice are more often evaluated in free-fall sorters, where objects are analyzed mid-air for shape, color, and foreign material detection. These 360 degree inspections can only be achieved by free fall systems where the objects are checked while they fall. This obviously also involves high speeds during inspection.

To make things even more demanding, many of these applications need very accurate color data, to distinguish small and challenging defects that appear in the same colour range like finding dark yellow spots on French fries. Another trend is the clearly growing demand for external and internal quality grading of food objects, which requires a multispectral or hyperspectral approach. This brings the need to look at both visible light for color inspection and NIR or SWIR wavelengths at the same time objects are passed. To check for damaged items that are not visible from the outside, for example bruises on apples that will sooner or later develop into rotten spots.



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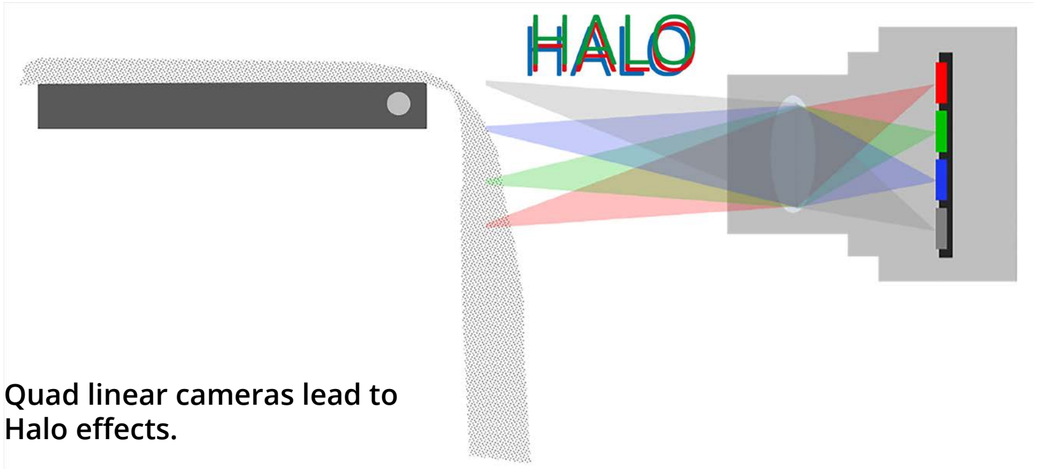
inspect: What are possible vision solutions for these requirements?

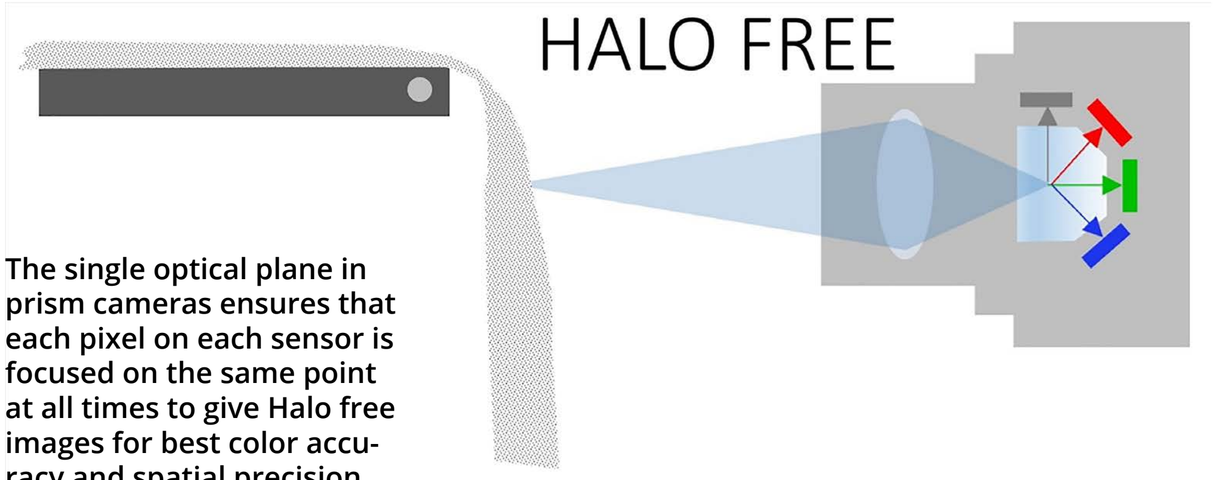
Cameron: There are various technical options on the market, like multi-camera solutions with separate waveband selection and

The JAI multi-channel cameras allow for getting simultaneous and separate inspection images of visible R-G-B light (400 to 700 nm) and NIR light (700 to 1,000 nm) or SWIR light (800 to 1,700 nm).

combining the images together. Or having two cameras looking through a beam splitter, that divides the image acquisition and inspection tasks, but this usually leads to synchronization issues, more complex set-ups and higher cost. Prism cameras on the other hand can optimally exploit their advantages under the conditions: They have the great ability to compromise depth of focus with difficult angles looking at objects, in such way that the image as output can be used directly. Prism cameras offer great opportunities to see visible and infrared wavelengths by using just one camera and supply multiple streams as output.



Quad linear cameras lead to Halo effects.



The single optical plane in prism cameras ensures that each pixel on each sensor is focused on the same point at all times to give Halo free images for best color accuracy and spatial precision.

This helps to be much more flexible with the set-up for focal distance, as you can easily change a different lens, which is more difficult with a beam-splitter set-up.

Prism cameras can solve the challenge of obtaining multispectral data in lane-sorting, belt-sorting and free-fall sorting machines to inspect, grade and sort food items looking at both visible and infrared (NIR or SWIR) light data. JAI offers 4-sensor prism-based line scan cameras that allow for simultaneously catching R-G-B images for precise color grading plus NIR or SWIR images to detect foreign objects like stones, stems and leaves or catch “under surface defects” like bruises or rot. An important feature for users is that, compared to multi-camera setups, this technology helps to reduce calibration and installation time.

inspect: How come JAI has such special products and prism cameras for this specific segment?

Cameron: JAI was one of the first industrial camera manufacturers offering these kinds of solutions for color inspection, using area-scan and line-scan camera types. Prism-based cameras separate light into red, green and blue or if required even NIR or SWIR wavelengths and direct the light to three respectively four separate and perfectly pixel aligned image sensors. With a single optical axis for all light bands, these cameras eliminate parallax issues, so-called Halo effects, and ease complex spatial alignment procedures associated with off-angle viewing, round objects, or objects falling at different speeds. There is only minimal color crosstalk between the colors because the precision-engineered hard dichroic filters with steep spectral cutoff direct the different pure wavelengths to the dedicated sensors, so you get true-to-life colors which improves the image quality and thus the inspection results.

JAI cameras even provide individual exposure control for each channel if there is a need to look at specific wavelengths. These features result in better, Halo free images with supreme color accuracy and spatial precision, helping users to obtain better and more consistent quality in their free fall sorting machines.

inspect: Apart from the food industry, are there other fields where JAI prism cameras offer advantages?

Cameron: Other examples are the recycling industry, the fields of textile, print and glass inspection, or even agriculture. These and many more industries can benefit from this technology. Applying prism blocks in cameras ensures that the collected light from objects can be transformed into true color information, making challenging color separation easier, no matter if you inspect food or other products.

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