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White Paper

Understanding How Electronic Sorting Technology Helps Maximize Food Safety

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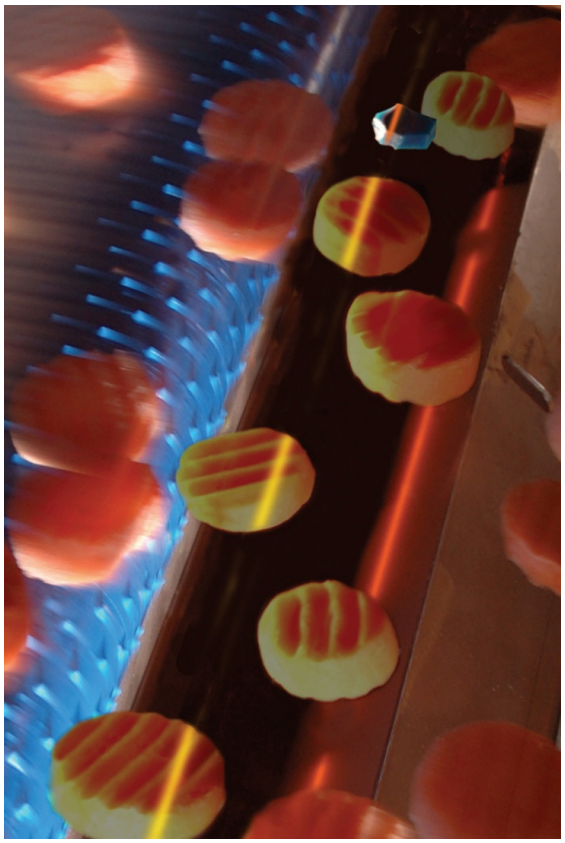
Product safety is one of the most important issues facing the food processing industry today. Food safety impacts consumer safety as well as product liability and brand protection. For manufacturers of processed fruits and vegetables, fresh-cut produce, snacks, confections, nuts, and potatoes, the elimination of foreign material is a critical piece of the food safety initiative.



To maximize the removal of foreign material, processors are rapidly replacing manual inspection with automated electronic sorters. Compared to manual inspection, which is inconsistent and subjective, electronic sorters are more effective in identifying and removing foreign material and product defects, while at the same time reducing labor costs and improving operating efficiencies.

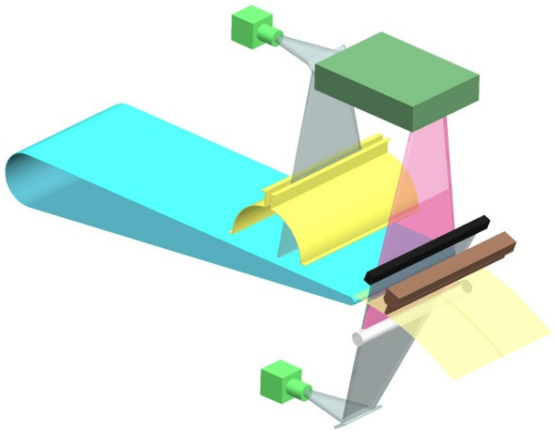
Processors supplying ingredients to other food manufacturers are increasingly finding that their customers are adopting a zero tolerance policy on foreign material. Many vendor qualification processes are demanding the use of automated sorters and validation systems that verify all foreign material incidences are properly tracked. In fact, sorters can now provide the processor with a time and date stamped photograph of all foreign material incidents. Processes that trace foreign material removal are becoming necessary to participate in the markets around the world that require high product quality.

In this article, we will explore electronic sorting technologies. The objective is to help food processors understand how to maximize food safety by identifying the criteria they should consider when selecting the ideal sorter for their products and applications.

Sorting Basics

Some sorters rely on cameras, others on lasers, and some combine cameras and lasers to view product from the top only or both top and bottom. Some sorters inspect only an object's color, others inspect an object's color, size, and shape, and some sort based on the object's structural properties, including differing levels of chlorophyll. The food processor's products and business objectives determine the suitable sorter configuration.

Regardless of configuration, most sorters contain similar basic elements. The upstream material handling component presents a single layer of product to the sorter for optimal viewing, and can perform some preliminary mechanical sorting by virtue of a product attribute such as size. The sorter's sensors capture data, which is analyzed by the sorter's image-processing system. Foreign material and defective product are ejected by either mechanical paddles or air jets.



Although sorters are designed for continuous, 100 percent, in-line inspection at full production speeds, they can also be used in a batch-feed mode. Typical sorters handle from one to 25 metric tons of product per hour.

Cameras and Lasers and Wavelengths

The ideal sorter for any given application combines the lights, cameras, lasers, and image processing software that most effectively differentiate good product from foreign material and product defects. To maximize that differentiation, it is important to identify the wavelengths that produce unique "signatures" for each object of interest. The sorter manufacturer might use a spectrophotometer on the food processor's products, foreign material, and defects to see how these objects respond to different wavelengths.

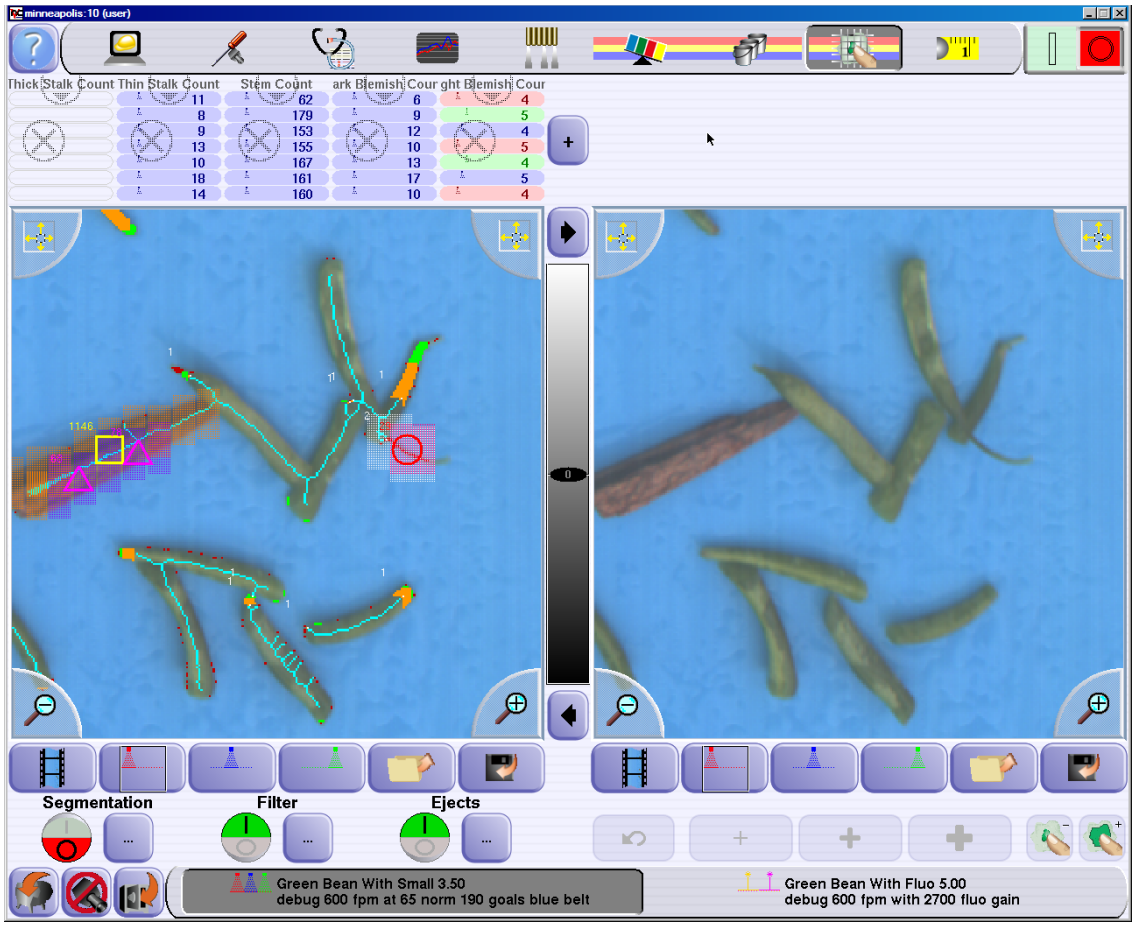
Cameras can be set to inspect within the visible range (red, green, and blue) or a combination of visible and Infrared (IR) or Ultraviolet (UV) spectrums. These cameras capture product information based primarily on material reflectance and, depending on the image processing software, can recognize foreign material and defects based on color, size, and shape.

Lasers are used primarily to inspect a material's structural properties, which make them ideal for detecting a wide range of foreign material and some product defects. Like cameras, lasers can be designed to inspect only within the visible range or within the IR or UV spectrums too. Additionally, lasers have the ability to detect varying levels of chlorophyll of all individual pieces in a stream of product.

Size, Shape, and Color

All sorters, even the simplest systems that rely only on monochromic (black and white) cameras, can detect differences in color (if only on the gray scale) to distinguish good product from foreign material and defects. But most sorters are capable of much more. Sophisticated color cameras are capable of detecting millions of subtle color differences to better distinguish good from bad objects. And the resolution of cameras and lasers differ with the highest resolution sensors able to detect the smallest defects and foreign material, as small as 1mm or less.

"Object-based recognition" enables a sorter to analyze attributes such as size, shape, symmetry, length, width, and curvature. Some sorters even allow the user to define a defective product based on the total defective surface area of any given object or the location of the defect on the product, if desired. These object-based considerations put more power into the processor's hands to produce optimal product quality.



Uses

The specific needs of each customer's application dictate the design of the ideal sorter. For some products, single-side viewing is sufficient. For other products, two-sided viewing with top and bottom sensors is needed to achieve the desired results.

Defects associated with sun exposure, wind rub, insect damage, rot, disease, and fungus as well as over- and under-ripe products, can all be removed with color camera-based sorters. But much more is possible with color sorting. One processor that packs peach slices in glass jars learned that customers prefer the color of the slices to be consistent. Mix yellow and orange slices in one jar and customers perceived the yellow slices as unripe and left the jar on the shelf. This processor used color sorting to separate the slices by color. The technology allowed them to pack jars with only yellow slices and jars with only orange slices. All the jars sold well and their sales increased.

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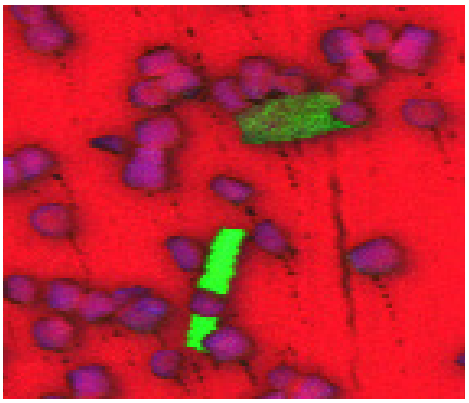
Attatched Stems Identified

Shape sorting can be used to differentiate green beans from same-color stems and knuckles. Extend this shape-sorting capability further and consider using the technology to separate straight green beans from curved ones. Such a separation would enable the processor to package straight beans in single serve packs and price them at a high mark-up while diverting curved beans to bulk product, thus increasing the overall value of the green beans.

Processors of leafy greens such as iceberg, romaine, cabbage, spinach, spring mix, mâche, butter leaf, arugula, and oakleaf as well as many nuts, processed fruits and vegetables, and potato products including strips and potato chips often find sorting with a combination of cameras and lasers most effective. The cameras detect defects based on color while the lasers detect insects and animal parts as well as sticks, rocks, cardboard, plastic, metal, and glass, even if they are the same color as the good product, based on the object's structural properties.

Fluorescence-sensing laser sorters are critical to processors whose products or defects contain chlorophyll. For example, cut corn kernels do not contain chlorophyll but the same-color husks and shanks do contain chlorophyll so fluorescence-sensing laser sorting is effective while color sorting is not. Likewise, same-color foreign material such as frogs, snakes, and insects found in leafy greens and green beans can easily be identified by the objects' differing levels (or absence) of chlorophyll, using a fluorescence-sensing laser sorter.



Chlorophyll-bearing Material Identified

Sorting is now driving a paradigm shift in how iceberg and romaine lettuces are processed. Traditionally, these lettuces are manually cored, which causes excess product to be cut away to assure the core is fully removed. Yield is lost. By integrating a vibratory density separation shaker with a camera/laser sorter, manual coring can be eliminated. Instead, whole, uncored heads of lettuce are brought into the plant and cut using the same automated cutting technology that is traditionally used to cut cored heads. After cutting, the integrated system removes the pieces of core as well as foreign material and defects from the product stream.

Manufactured snacks and confectionary products benefit from color sorting that removes color defects and intelligent shape sorting that removes broken and/or misshapen products. Laser sorting can be used to inspect wrapped confections and will remove candies with partial wraps or missing wrappers.

Sorter Selection Criteria

When searching for the perfect sorter for any given application, performance, capacity, flexibility, and economics should be considered along with the sorter manufacturer's expertise and support.

When comparing systems, consider the resolution of the cameras and lasers because higher resolution allows the sorter to detect and remove smaller defects. Compare cameras and their ability to detect possibly millions of subtle color differences. Compare the illumination system (usually either fluorescent, LEDs, or HID), understanding that superior lighting leads to superior sorter performance. Of course, the effectiveness of the sorter relies on the software too – the algorithms – that manipulate raw data and categorize information based on the customer-defined accept/reject thresholds.

Sorters are sophisticated pieces of equipment based on technology that advances at a rapid rate. To continue to get the most from a sorter and maximize the return on investment, look for a modular sorter that is designed to be easily upgraded or reconfigured in the field.

Last but not least, it is important to consider the level of service a supplier can provide in a specific region – from engineering to after-sales support.

The Bottom Line

Not long ago, using automated sorting to maximize product quality was a point of differentiation that led to a competitive advantage. Today, automated sorting is quickly becoming a necessary component of many food processing operations because customers are increasingly demanding the use of this technology to assure consistent product quality and traceability of all foreign material incidents.

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