RADIANT
VISION SYSTEMS

Quantifying Human Vision: Using Photometry-based Imaging Systems for Cosmetic Surface Inspection

Advanced Vision—a new class of automated visual inspection technology—combines the automation benefits of traditional machine vision with the sensitivity of true human vision to detect subtle cosmetic defects and ensure consistent product quality.

Today, customers expect flawless electronic devices right out of the box. Scratched, dented, and otherwise imperfect products can result in damage to your brand reputation and future business. How can you ensure consistent visual quality in the cosmetic appearance of delivered products?

Human quality inspectors apply their acute visual perception and immediate qualitative judgment to spot imperfections, regardless of where or how unexpectedly they may occur. However, faster production rates make it difficult for humans to spot subtle defects consistently while keeping up with throughput demands. Automated (machine-based) inspection systems inspect with greater speed and consistency, yet traditional machine vision systems just can't match the adaptability and visual sensitivity of humans.
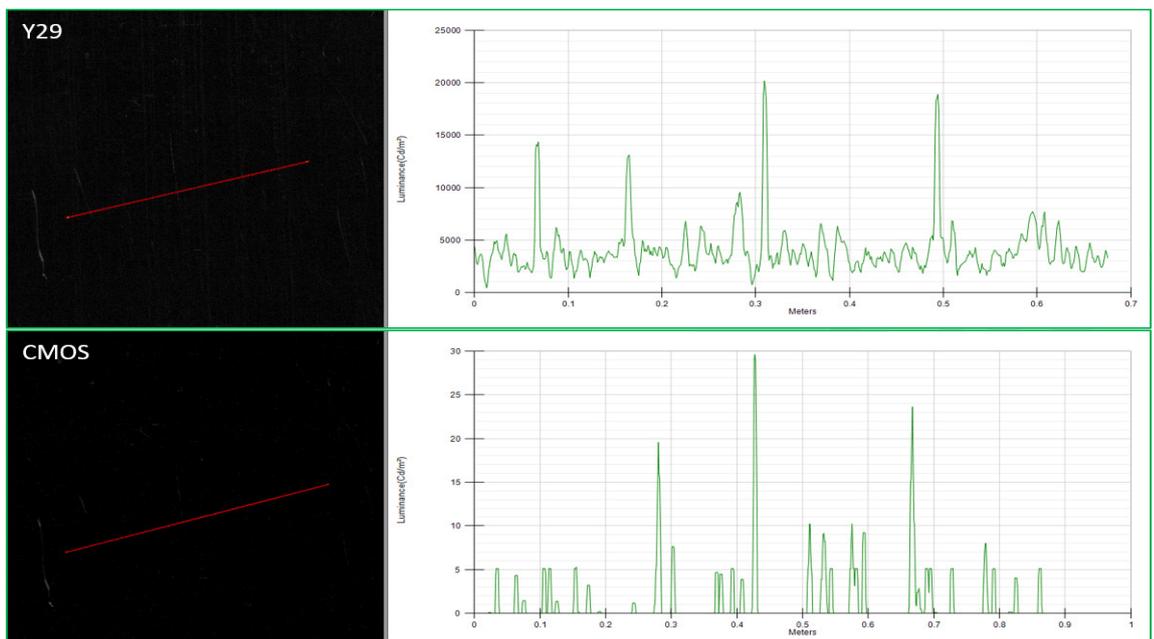
Photometry-based Vision Systems

Photometry-based imagers are engineered to detect subtle variations in light. Traditionally applied for measuring brightness and uniformity over large spatial areas—like an illuminated display—these systems are correlated to human visual sensitivity. Radiant's Advanced Vision approach uses photometry-based imaging to combine the speed and consistency of machine automation with the precision and adaptability of human vision. Our capabilities exceed those of traditional machine vision cameras for inspecting cosmetic defects on surfaces or particles and imperfections in glass. Like the human eye, photometric imaging systems quickly detect anomalous features. Software then grades these defects based on their location, scope, and severity so manufacturers can make a determination to ship, rework, repair, or discard a device.

Scientific Imaging. Radiant's visual inspection systems pair specialized optics and imaging technology with advanced algorithms to locate and characterize cosmetic defects. Our imaging systems feature scientific-grade CCDs with extremely high resolution, dynamic range, and signal-to-noise ratio for precise and repeatable measurements. Image noise is carefully reduced by testing each CCD's specifications and applying built-in sensor cooling, enabling our CCD imaging systems to detect more surface variations and defects than even the highest-megapixel CMOS cameras.

Luminance variations are detected across a device surface using Radiant's ProMetric Y29 (29 megapixel) Imaging Photometer (top), indicating surface defects like scratches or dents. Only a limited set of these luminance variations are detected by a 71-megapixel CMOS imager (bottom), missing one peak variation at around 0.08 meters that indicates a cosmetic scratch, which was detected by the ProMetric camera.

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Sophisticated Software

Radiant solutions include sophisticated software algorithms to locate and characterize randomly-occurring cosmetic defects on device surfaces, including unknown defects in unpredictable locations. By taking a complete spatial image of a device, our systems perform uniformity checks to detect hairline scratches, subtle dents, and smudges across device surfaces. This photometry-based inspection approach combines camera systems and software to "perceive" surface cosmetic defects the way that humans do, first by capturing images with resolution and dynamic range that match human vision, and then applying specialized algorithms that match human perception.

Radiant's Advanced Vision systems can classify the severity of each defect against acceptable tolerances and determine pass/fail, just as humans use their judgment to determine a reasonable margin of error.
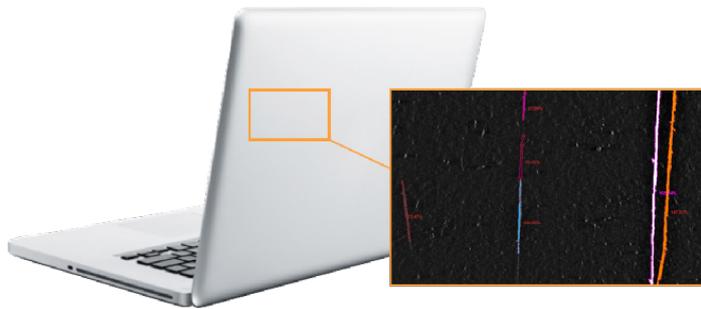
Scratches on the back of a laptop are identified and qualified based on their severity. The values shown in this analysis image provide contrast ratios relative to a background level.

Data Capture & Analysis. Unlike human inspectors, Radiant software applies numeric values to each defect to determine severity—quantifying defects by size, shape, location, frequency, and rate of occurrence and building trend analysis data that allow you to fine-tune processes, improve product quality, and increase production efficiency.
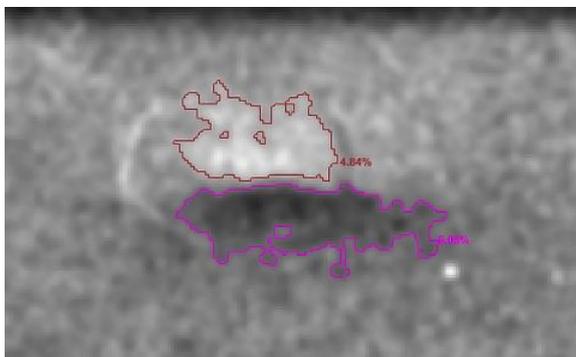
The length and width of a dent can be measured against defined thresholds to determine if the product passes or fails.

Capability. Photometry-based vision systems excel at cosmetic inspection of device surfaces (case, bezel, buttons, marks, etc.). These systems can detect defective features in device housing (below right), as well as defects on glass like smudges (below left), which draw on Radiant's extensive light measurement algorithms for detecting "mura" in illuminated displays.


Inspecting the front and back surfaces of a tablet.

Flexibility. Built on Radiant's automated visual inspection software, our Advanced Vision systems can simultaneously perform inspections for part orientation, assembly verification, fit & finish analysis, and text/label legibility, eliminating the need for a separate machine vision system to perform these inspections on the line.

Eliminating Particle Defects on Surfaces

With extremely high-resolution (to 43 megapixels) and high-dynamic-range (up to 61 dB depending on sensor option) CCD imaging, Radiant systems can also detect unwanted particles on surfaces, glass, and transparent layers. Dynamic range increases the number of grayscale values in each image, ensuring that subtle contrast variations are identifiable to inspect fine details. The specifications of Radiant cameras ensure that pixel-sized particles are clearly discernable from image noise, so they can be identified and removed before shipping.
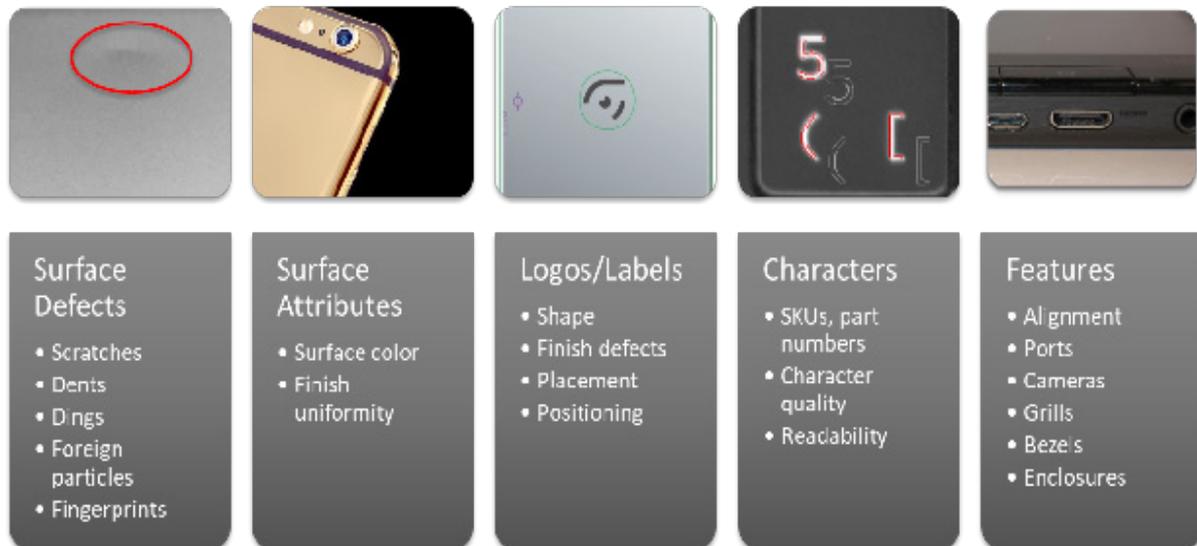
Test Image
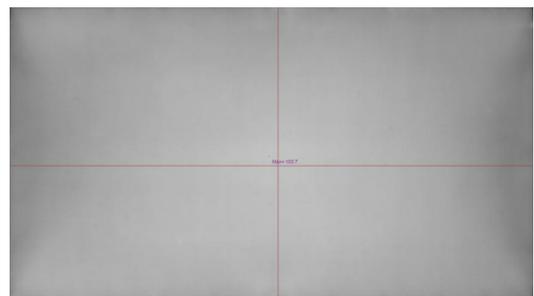
Final Analysis
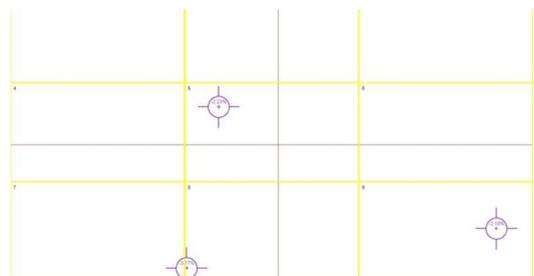
Radiant automated visual inspection software detects particles on this metallic surface, which can cause unwanted variations in surface finish.

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The Power of Advanced Vision

Used for cosmetic surface inspection, Advanced Vision systems provide all the benefits of automated inspection, including objective analysis and quantifiable results, while capturing the data needed for error tracking to improve production operations. Radiant software provides an extensive set of machine vision inspection tools for production-level monitoring and pass/fail test sequencing to enable manufacturers to automate any visual quality inspection process.

Radiant's photometry-based systems can detect defects that may be missed by human inspectors, and can also be used to inspect components with imperceptibly precise tolerances, such as keyboards (measuring gaps between keys, characters, etc.), glass & transparent layers (particle detection, air bubbles), and more.

Surface Defects
- Scratches
- Dents
- Dings
- Foreign particles
- Fingerprints

Surface Attributes
- Surface color
- Finish uniformity

Logos/Labels
- Shape
- Finish defects
- Placement
- Positioning

Characters
- SKUs, part numbers
- Character quality
- Readability

Features
- Alignment
- Ports
- Cameras
- Grills
- Bezels
- Enclosures

Advanced Vision inspection addresses assembly verification and all aspects of appearance, fit, and finish.

Recognized for Innovation

Radiant Vision Systems was honored with a Silver-level award at the *Vision Systems Design* 2017 Innovators Awards, and a 2018 GLOBAL Technology Award in the category of "Inspection AOI" for our INSPECT.assembly automated visual inspection station, which leverages Advanced Vision imaging and software.

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