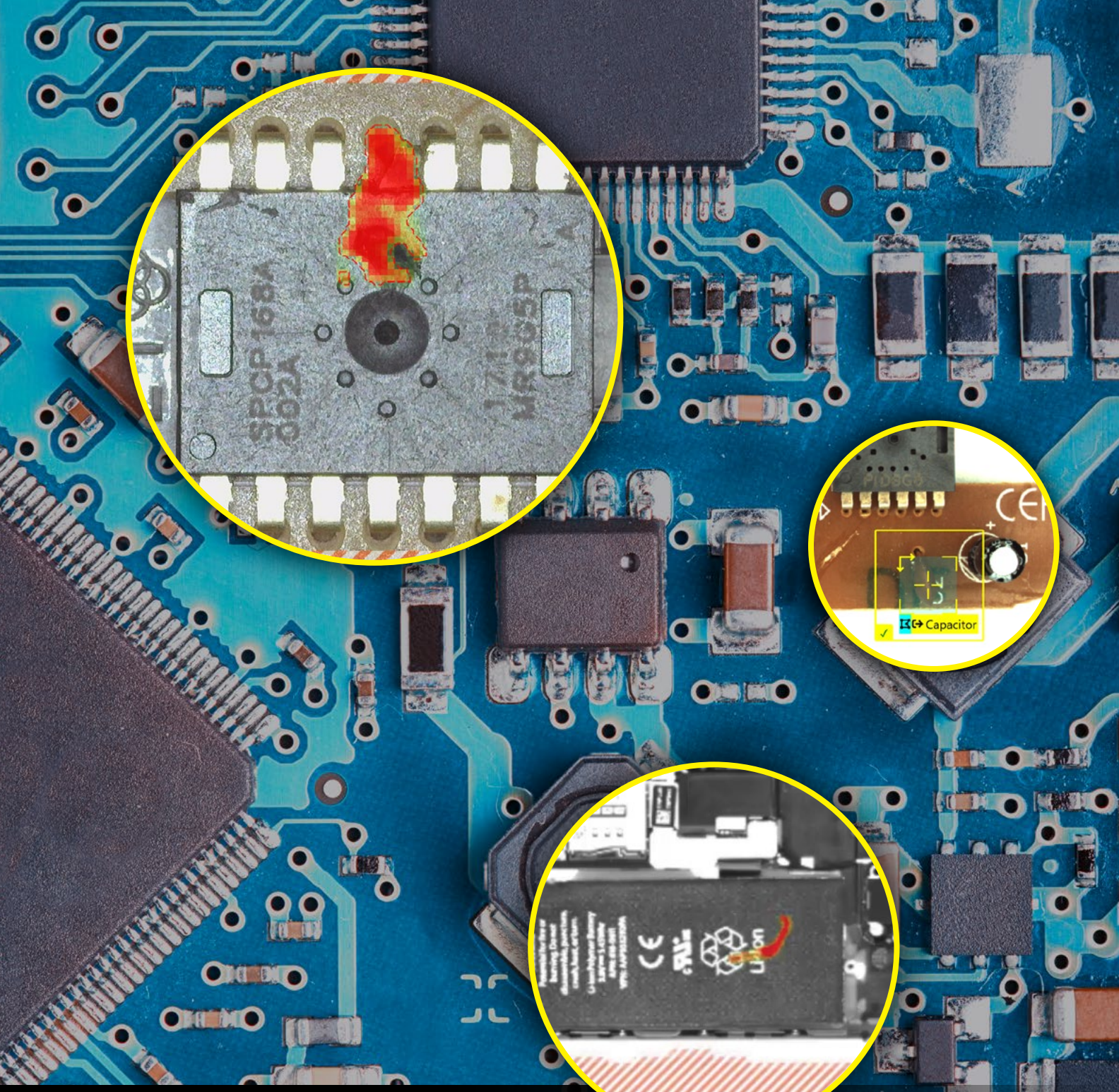


COGNEX DEEP LEARNING

Deep Learning-based Solutions for the Electronics Industry

COGNEX

THE GLOBAL LEADER

IN MACHINE VISION AND INDUSTRIAL BARCODE READING

Cognex,® the leading supplier of machine vision and industrial barcode reading solutions.

With over 2.3 million systems installed in facilities around the world and over thirty nine years of experience, Cognex is focused on industrial machine vision and image-based barcode reading technology. Deployed by the world's top manufacturers, suppliers and machine builders, Cognex products ensure that manufactured items meet the stringent quality requirements of each industry.

Cognex solutions help customers improve manufacturing quality and performance by eliminating defects, verifying assembly and tracking information at every stage of the production process. Smarter automation using Cognex vision and barcode reading systems means fewer production errors, which equates to lower manufacturing costs and higher customer satisfaction. With the widest range of solutions and largest network of global vision experts, Cognex is the best choice to help you **Build Your Vision.™**

$726 MILLION
2019 REVENUE

OVER 39
YEARS IN THE BUSINESS

500+
CHANNEL PARTNERS

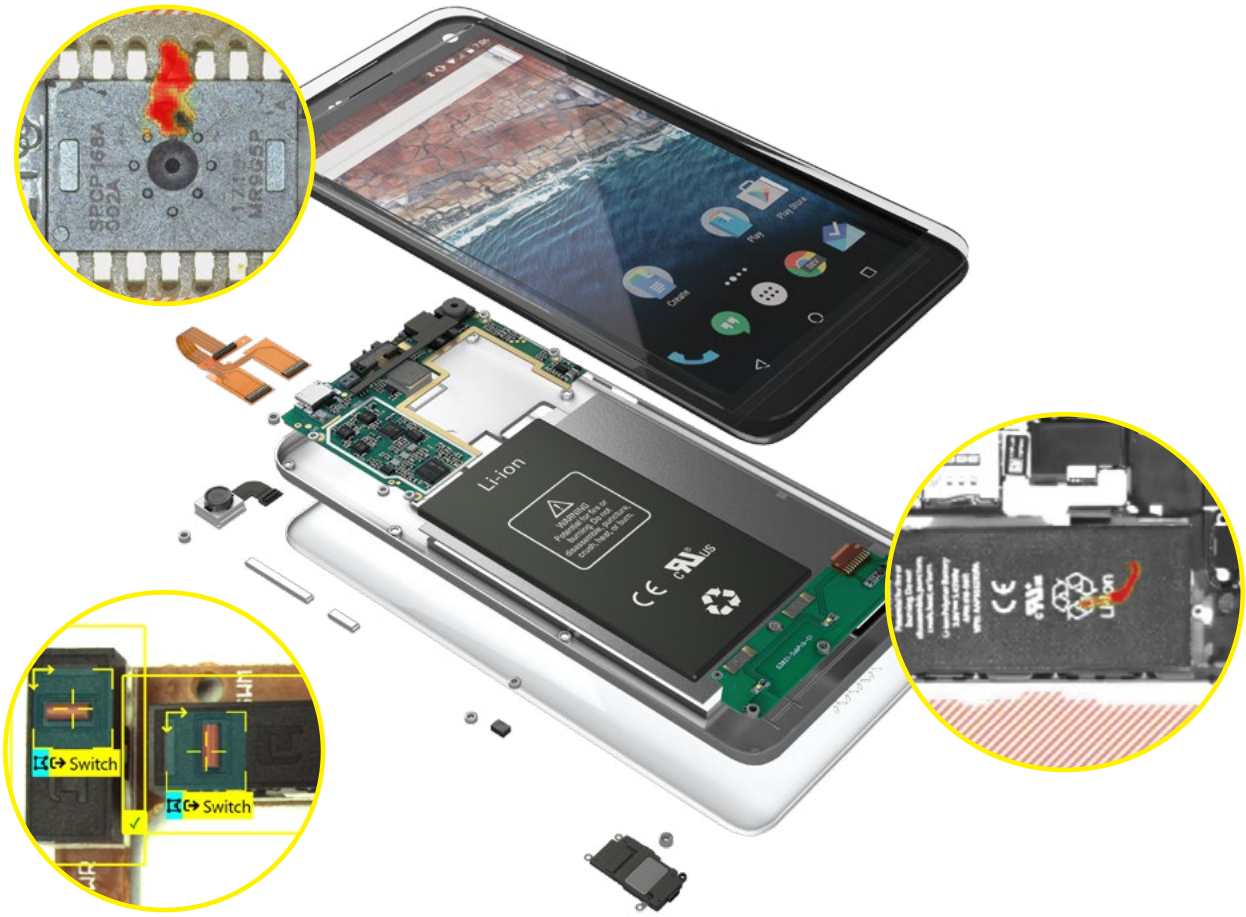
GLOBAL OFFICES IN
20+ COUNTRIES

2,300,000+
SYSTEMS SHIPPED

DEEP LEARNING-BASED SOLUTIONS FOR THE ELECTRONICS INDUSTRY

Automating production processes and improving quality are two of the electronics industry's greatest demands. Yet some applications are too complicated, time-consuming, and expensive to program into a rule-based algorithm. Using human inspectors to handle various part types and make judgement-based decisions can also introduce error and slow down production.

Cognex Deep Learning is the first deep learning vision software designed to solve challenging electronics applications requiring part location, cosmetic inspection, classification, and character recognition. Cognex Deep Learning offers human-like inspection capabilities with the speed and robustness of a computerized system, in a field-maintainable unit that makes it easy to train new parts and defect types in the field.



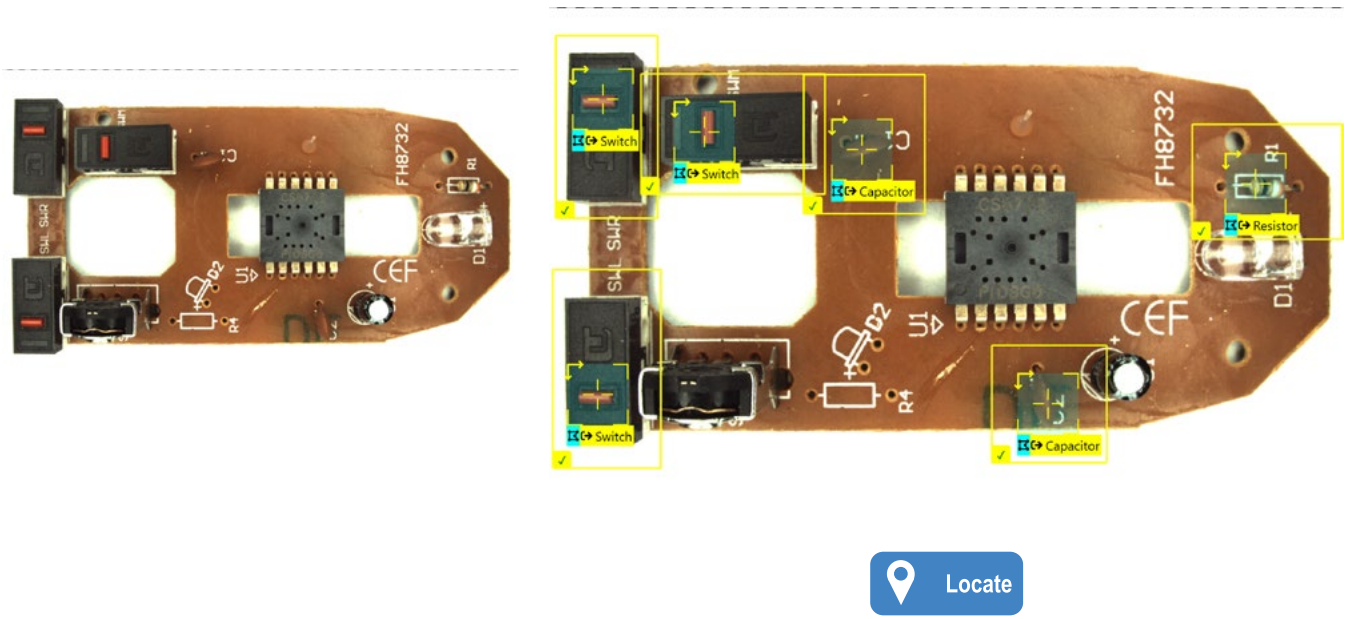
PRINTED CIRCUIT BOARD ASSEMBLY VERIFICATION

CHALLENGE

During final assembly verification, 2D and 3D machine vision systems traditionally inspect PCBs for the presence and correct placement of LEDs, microprocessors, and other surface mount devices. Wrongly positioned or missing components can impact a PCB's performance and lifespan. These errors must be caught before PCBs are assembled into devices or shipped to customers. Yet slight variations in appearance—whether due to subtle lighting contrasts, changes in perspective and orientation, or glare on metallic surfaces—can confuse an automated inspection system. Parts which are close together are difficult for a machine vision system to distinguish as independent components. Programming these inspections into a rule-based algorithm is time-consuming, prone to error, and challenging for a field engineer to maintain. Human inspectors, though capable of identifying these components, cannot meet high-speed processing demands.

SOLUTION

VisionPro ViDi offers a field-maintainable solution that rivals human inspection to verify the assembly of a PCB. The ViDi Blue-Locate tool learns to identify the components from annotated "good" images, building a reference model of their normal appearance. The tool generalizes the distinguishing features of the components based on their size, shape, and surface features and learns their normal appearance, as well as their general location on the board. During runtime, the ViDi Blue-Locate tool analyzes all the relevant areas of the board to identify and count components, despite their changing appearance. In this way, the inspection determines whether the components are present or absent and can tell whether the board has been assembled correctly.



ViDi Blue-Locate identifies and counts components on a PCB.

SOLDER RESIST INSPECTION

CHALLENGE

For a component like a mouse diode to be mounted without interference to its electrical connection, solder resist must be applied cleanly to a bare board. Even small defects in the solder can cause wiring breakages, shorts, and other electrical problems. These defects vary in size, shape, and appearance due to specular glare. It is difficult to program an automated inspection that tolerates significant part variation under these conditions.

SOLUTION

VisionPro ViDi quickly identifies the solder resist on a diode when other methods struggle to inspect under the same lighting conditions. The ViDi Blue-Locate tool trains on a set of representative images of solder resist to learn the normal appearance of “good” and “bad” solder. During runtime, the Blue-Locate tool fixtures and locates resist on the PCB, despite variations in specular glare. During the second stage of the inspection, the solder resist must be inspected to find any functional anomalies, such as bridging, peaking, or gapping. Using the ViDi Red-Analyze tool in supervised mode, the user can train the tool on a representative set of known “good” solders and “bad” solders with labeled defects.

Based on these images, ViDi learns the natural texture of the mouse diode, as well as the normal appearance of its solder. Additional images can be added to the training set during validation testing to reflect additional examples and optimize the model. Various parameters can be adjusted during the training and validation phase to help account for variations in appearance to correctly detect all the diodes with defective solder.

ViDi Blue-Locate locates solder resist on the PCB. Then, ViDi Red-Analyze identifies those that are defective.

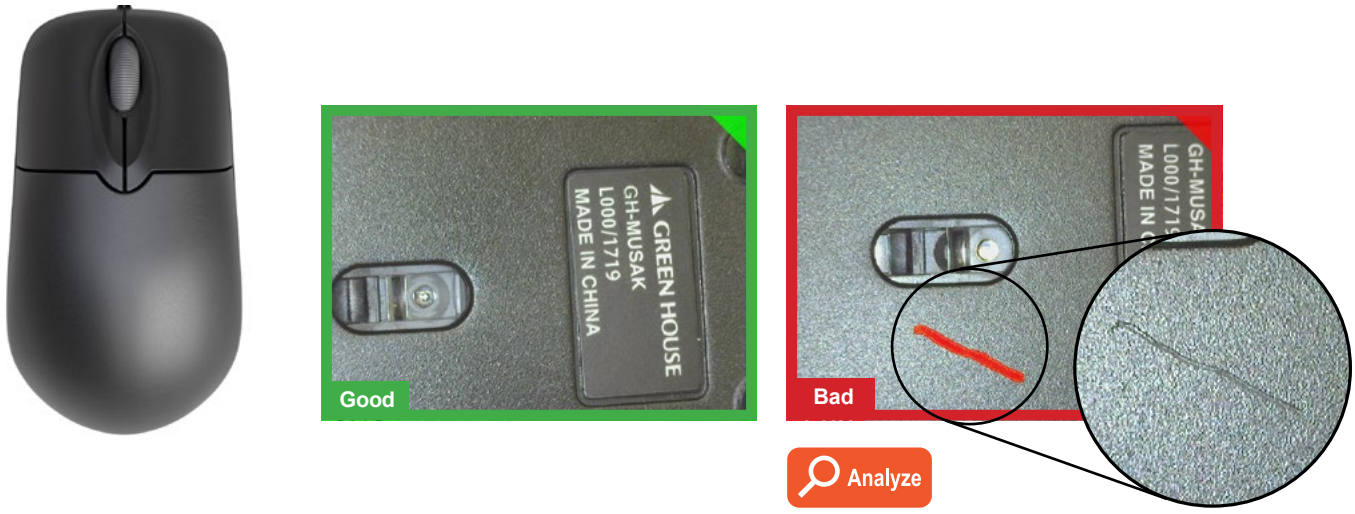
HOUSING COSMETIC INSPECTION

CHALLENGE

Cosmetic inspections can be challenging when parts vary, whether at the component level or at the packaging and housing level. Scratches, dents, and other cosmetic defects may not affect functionality but do affect finished quality and consumer perception. Some cosmetic defects may be obvious cause for rejection, while other minor defects are acceptable. For this reason, manufacturers need to train an inspection system to search for specific defects and differentiate them from minor blemishes. Programming an inspection of this complexity into a rule-based algorithm requires complex defect libraries. Human inspection, though more flexible, is too slow, unreliable, and inconsistent.

SOLUTION

Using the ViDi Red-Analyze tool in supervised mode, an engineer can train VisionPro ViDi to search for specific defects, such as scratches, while tolerating unimportant anomalies and variations. The Red-Analyze tool is optimized to work with images that are low-contrast or are poorly captured. For example, the images below illustrate how the ViDi Red-Analyze tool analyzes both good and bad images of a mouse. During runtime, the software characterizes images with severe scratches as defective, having learned to recognize and ignore minor cosmetic blemishes.



The ViDi Red-Analyze tool analyzes cosmetic anomalies on the mouse.

PRE-ASSEMBLY INSERTION CHECK AND BATTERY MODULE COSMETIC INSPECTION

CHALLENGE

During a pre-assembly insertion check, the contents of a phone are inspected for defects before the cover is assembled. Batteries can be damaged as they are guided onto the housing. Locating and inspecting the battery is difficult due to the confusing, busy background of the phone assembly. Deep learning vision software simplifies the automated detection and characterization of defects on the battery's metal surfaces.

SOLUTION

VisionPro ViDi allows the manufacturer to check the battery's integrity before the phone undergoes final assembly, and to differentiate between cosmetic and functional anomalies. Using the ViDi Red-Analyze tool in supervised mode, an engineer can train the software on "good" images as well as "bad" images with labeled defects. From these images, the Red-Analyze tool learns the battery's normal appearance, including natural acceptable variations. Parameters can continually be adjusted during the training phase and validation period until the trained model correctly detects and segments all images with functional anomalies. Once deployed, the Red-Analyze tool identifies and rejects batteries with defects.

ViDi Red-Analyze learns to identify variations amongst the battery modules to catch defects.

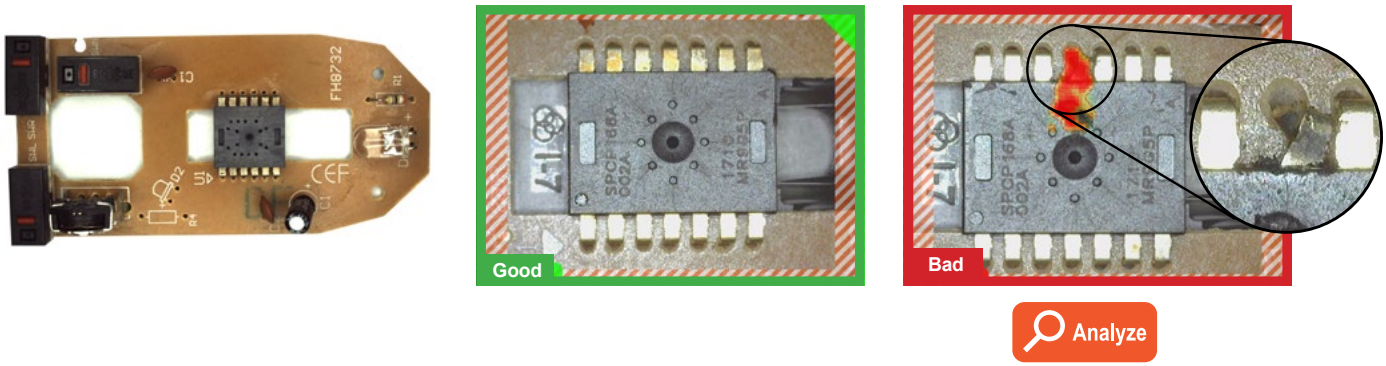
IC LEAD COSMETIC INSPECTION

CHALLENGE

Machine vision is used throughout the semiconductor manufacturing process to rigorously monitor quality and catch defects. Manufacturers must be vigilant for scratched, twisted, bent, or missing pins. A chip has such low tolerances for error that any flaw, even the most superficial, is cause for rejection. With so many potential defect types, it is inefficient to program an inspection into a rule-based algorithm. Deep learning vision software can help limit semiconductor defects and improve yield without the use of extensive defect libraries.

SOLUTION

Explicitly searching for all defects is too complicated and time consuming. VisionPro ViDi offers a simple solution to identify all anomalous features, even without training on “bad” images. Instead, an engineer uses the ViDi Red-Analyze tool to train the software on a sample of “good” images in unsupervised mode. ViDi learns the normal appearance and position of a chip’s leads and pins and characterizes all features that deviate as defective.



ViDi Red-Analyze identifies defective pins on an IC.

CAPACITOR CLASSIFICATION

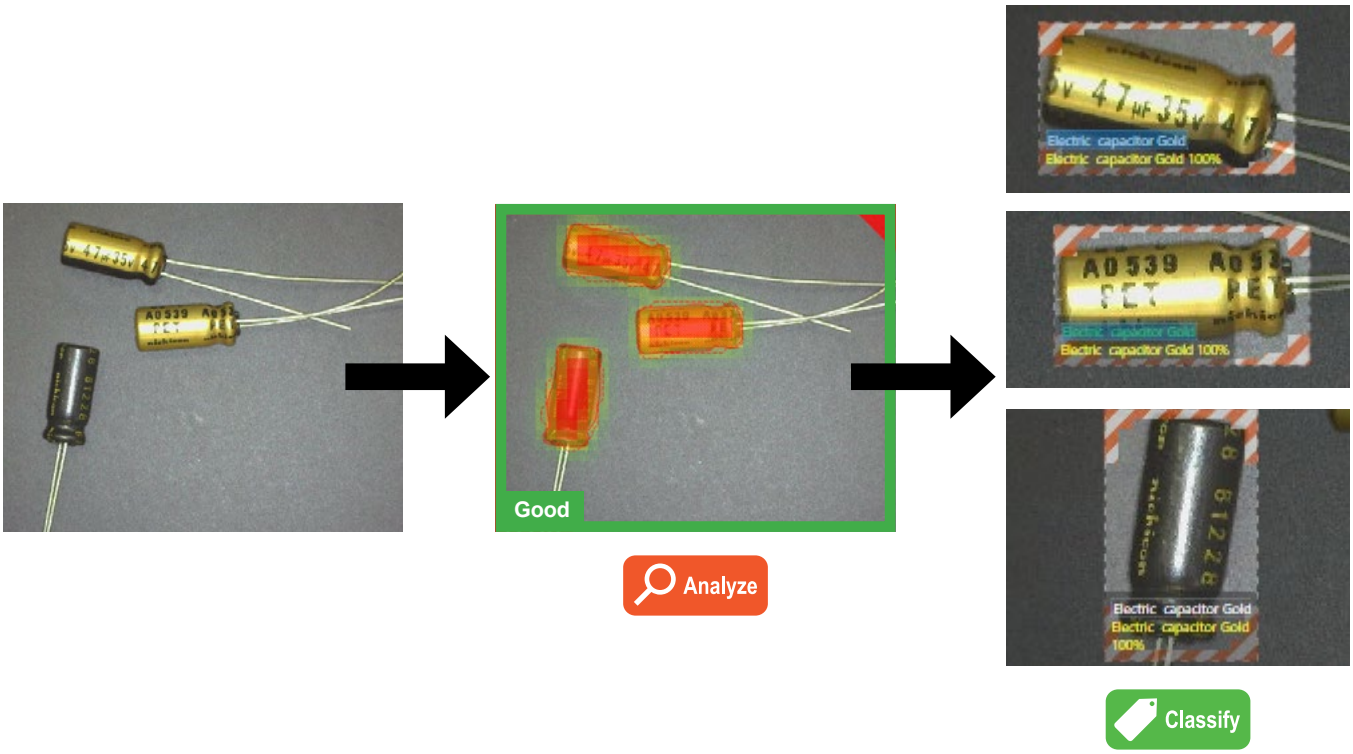
CHALLENGE

Classifying electronic components can be especially challenging when parts fall into multiple classes, each with some visual variation. Capacitors vary in type (ceramic and electric) and also by size and color, depending on their manufacturer and specifications. Even within the same type, there can be confusing variations in pattern. Their cylindrical shape and lighting can add even more complexity. VisionPro ViDi offers a deep learning-based alternative to automate multiple classifications within a single image.

SOLUTION

Using the ViDi Red-Analyze tool, an engineer trains the software in supervised mode on a set of annotated images where both gold and electric capacitors are categorized as “good” parts. During runtime, the model extracts and segments all electric and gold capacitors as one type.

In the second part of the inspection, the ViDi Green-Classify tool learns the attributes of each capacitor, while tolerating variation within the same type. In this way, it can distinguish different electric capacitors by their color and marking, even though they look visually similar. Based on the model developed during training, ViDi accurately classifies and sorts capacitors within a single image during runtime.



ViDi segments capacitors dynamically, then classifies them by type.

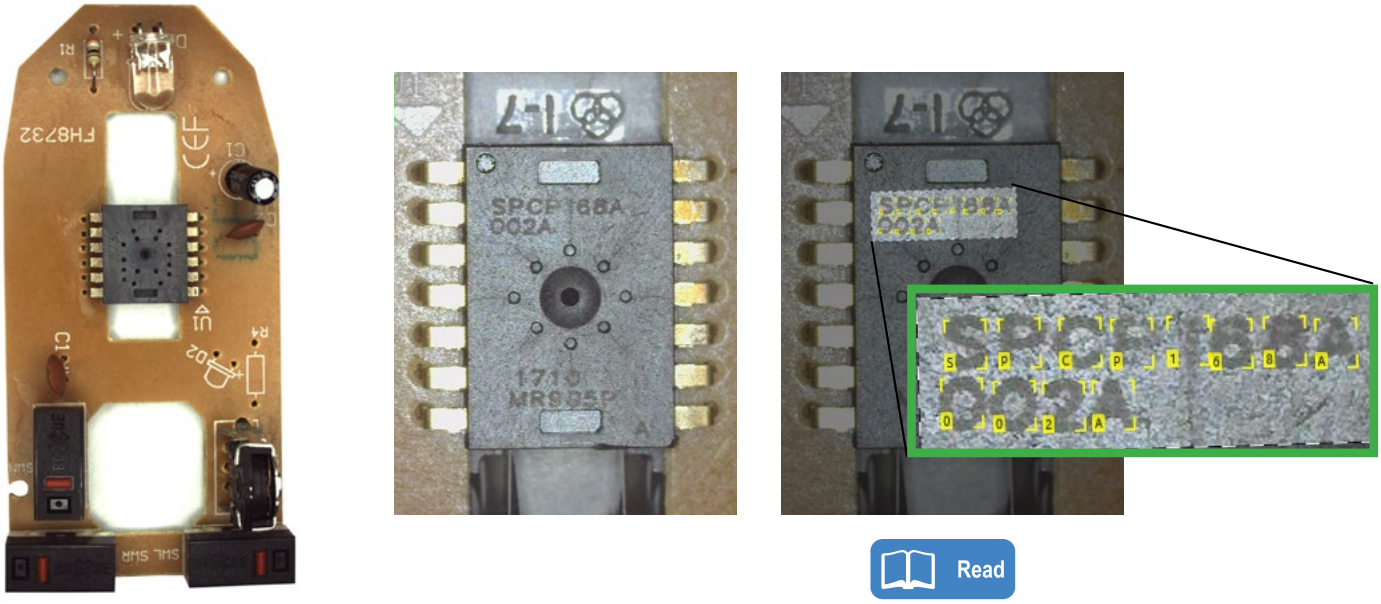
OPTICAL CHARACTER RECOGNITION ON A CHIP

CHALLENGE

Most chips are labeled with a string of alphanumeric characters to track them through production. Specular glare can result in low-contrast images, which make it difficult for a machine vision system to locate and recognize characters. To successfully decode characters on electronic components and modules, an optical character recognition (OCR) system needs to tolerate reflective surfaces as well as deformed, skewed, and poorly-etched characters.

SOLUTION

With the ViDi Blue-Read tool, it is easy to read deformed characters, despite image formation challenges. This new deep learning-based approach to OCR saves time during training and development by reducing excessive labeling, and successfully reads characters in challenging situations. The Blue-Read tool simply requires an engineer to set a region of interest and character size. Once set, the tool's pretrained font library deciphers characters and reads strings without training. In situations where characters are very difficult to read, the Blue-Read tool can be retrained directly using characters with variations.



ViDi Blue-Read recognizes deformed characters on a chip despite image formation issues.

COGNEX DEEP LEARNING SOLUTIONS

Cognex Deep Learning is the first set of deep learning-based vision solutions designed specifically for factory automation. The field-tested, optimized and proven technology is based on state-of-the-art machine learning algorithms.

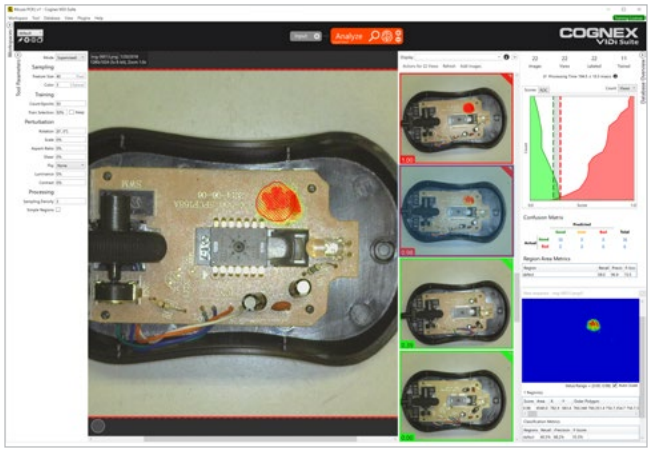
Rather than following a rule-based approach to solving inspection challenges, like traditional machine vision applications, Cognex's deep learning solutions learn to spot patterns and anomalies from reference image examples. Deep learning automates and scales complex inspection applications that until now still required human inspectors such as defect detection and final assembly verification.

In-Sight ViDi

In-Sight® ViDi deep learning applications are deployed on the In-Sight D900 smart camera without the need for a PC, making deep learning technology accessible to non-programmers. It uses the familiar and easy-to-use In-Sight software platform which simplifies application development and factory integration.

VisionPro ViDi

VisionPro ViDi deep learning software combines a comprehensive machine vision tool library with advanced deep learning tools inside a common development and deployment framework. It simplifies the development of highly variable vision applications and allows engineers to build flexible, highly customized deep learning solutions tailored to their specific needs.



BUILD YOUR VISION

2D VISION SYSTEMS

Cognex machine vision systems are unmatched in their ability to inspect, identify and guide parts. They are easy to deploy and provide reliable, repeatable performance for the most challenging applications.

www.cognex.com/machine-vision

3D VISION SYSTEMS

Cognex In-Sight laser profilers and 3D vision systems provide ultimate ease of use, power and flexibility to achieve reliable and accurate measurement results for the most challenging 3D applications.

www.cognex.com/3D-vision-systems

VISION SOFTWARE

Cognex vision software provides industry leading vision technologies, from traditional machine vision to deep learning-based image analysis, to meet any development needs.

www.cognex.com/vision-software

BARCODE READERS

Cognex industrial barcode readers and mobile terminals with patented algorithms provide the highest read rates for 1D, 2D and DPM codes regardless of the barcode symbology, size, quality, printing method or surface.

www.cognex.com/barcodereaders

COGNEX

Companies around the world rely on Cognex vision and barcode reading solutions to optimize quality, drive down costs and control traceability.

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