COGNEX DEEP LEARNING

Easy-to-Deploy Deep Learning-based Solutions for the Automotive 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 3.5 million systems installed in facilities around the world and over forty one 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.™**

$1.04 BILLION
2021 REVENUE

OVER 41
YEARS IN THE BUSINESS

500+
CHANNEL PARTNERS

GLOBAL OFFICES IN
20+ COUNTRIES

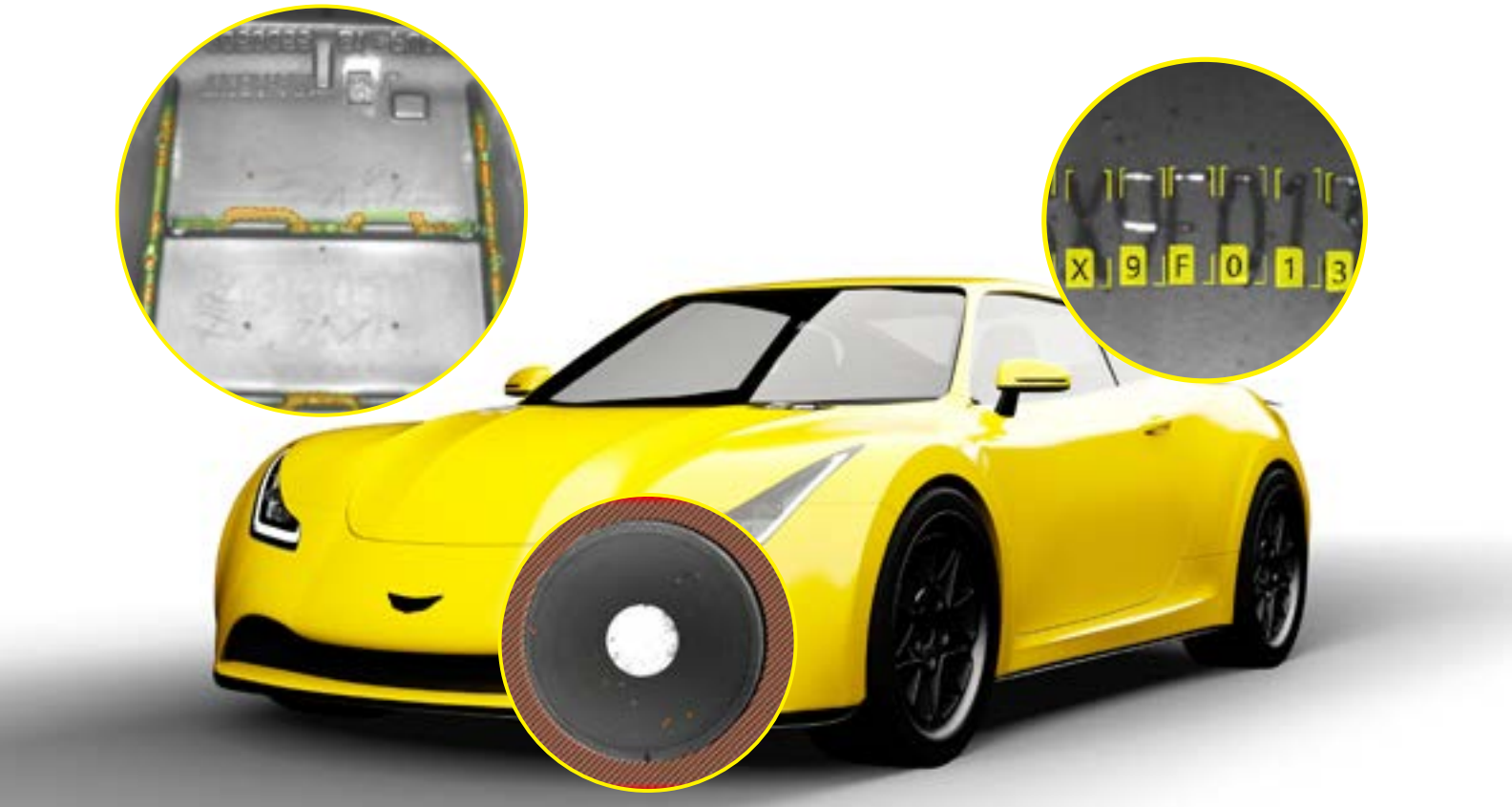
3,500,000+
SYSTEMS SHIPPED

DEEP LEARNING-BASED SOLUTIONS FOR THE AUTOMOTIVE INDUSTRY

Automate complex applications – no machine vision or programming experience required

Cognex Deep Learning is an image-based analysis software designed to automate and scale a wide range of applications across the automotive industry. Combining human-like intelligence with the robustness of machine vision, Cognex Deep Learning performs judgment-based part location, inspection, classification, and character recognition tasks with high accuracy and repeatability.

Using an intuitive interface and common development platform, the software simplifies application development, allowing even non-vision experts to deploy reliable automation. Cognex Deep Learning can easily be adapted to meet changing needs, providing a future-proof solution that grows with your business.



PISTON RING INSPECTION

The defect detection tool simplifies the automated detection and characterization of defects on textured metal surfaces

CHALLENGE

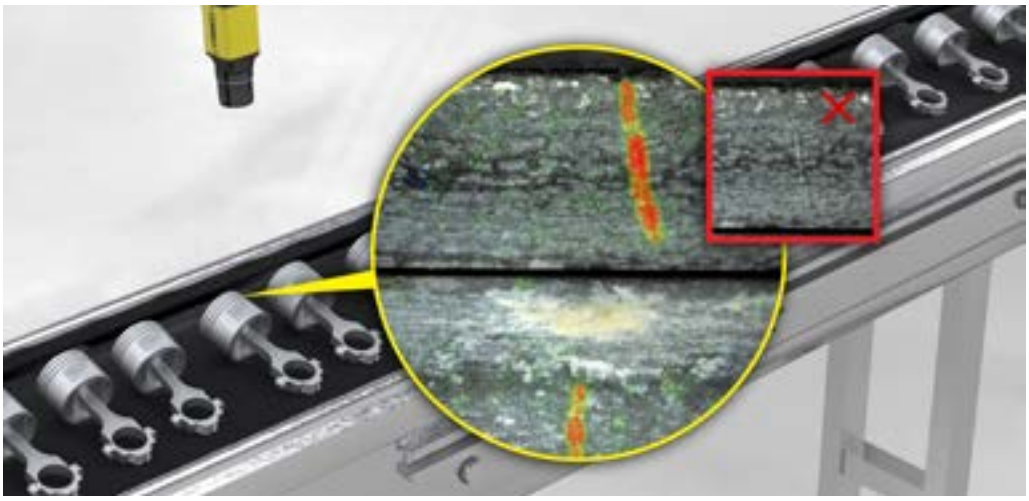
A piston's compression rings serve several functions in a reciprocating engine, sealing the combustion chamber and regulating oil consumption. Defects on a compression ring are difficult to detect because of the piston's reflective metallic surface. The cylindrical shape of the piston sometimes renders as blurry and un-focused in images. Normal variations in the metal's surface texture are to be expected as part of the manufacturing process, and some—including rust spots, white areas, and even surface cracks and fissures--are permitted to pass inspection. Long scratches that affect the piston's performance and threaten compression levels in the cylinder, however, are indications of true defects. An inspection system must be able to tolerate normal variations and insignificant anomalies on compression rings' surfaces while identifying any long scratches.

SOLUTION

Programming an inspection of this complexity into a rule-based algorithm would require complex defect libraries. Human inspection, though more flexible, would be too slow. Cognex Deep Learning offers an effective inspection solution, combining a human's ability to appreciate minor variations with the reliability, consistency, and speed of an automated system.

Using the defect detection tool in supervised mode, an engineer trains the deep learning-based software on a representative set of known "good" and "bad" compression ring images. A technician annotates known "bad" images where long scratches occur and "good" images with normal variations and tolerable defects, including rust spots and small cracks. Based on these images, the application learns a piston's natural form and surface texture, as well as the normal appearance of scratches. Additional images can be added to the training set during validation testing to reflect additional examples and help optimize the system. Parameters can continually be adjusted during the training phase and validation period until the trained model correctly detects and segments all images with long scratches.

During run-time, the software characterizes images with long scratches as defective, having learned to recognize and ignore irrelevant variations.



Cognex Deep Learning identifies defects on a piston's compression ring.

CYLINDER INSPECTION

Defect detection tool reliably detects pores in metal

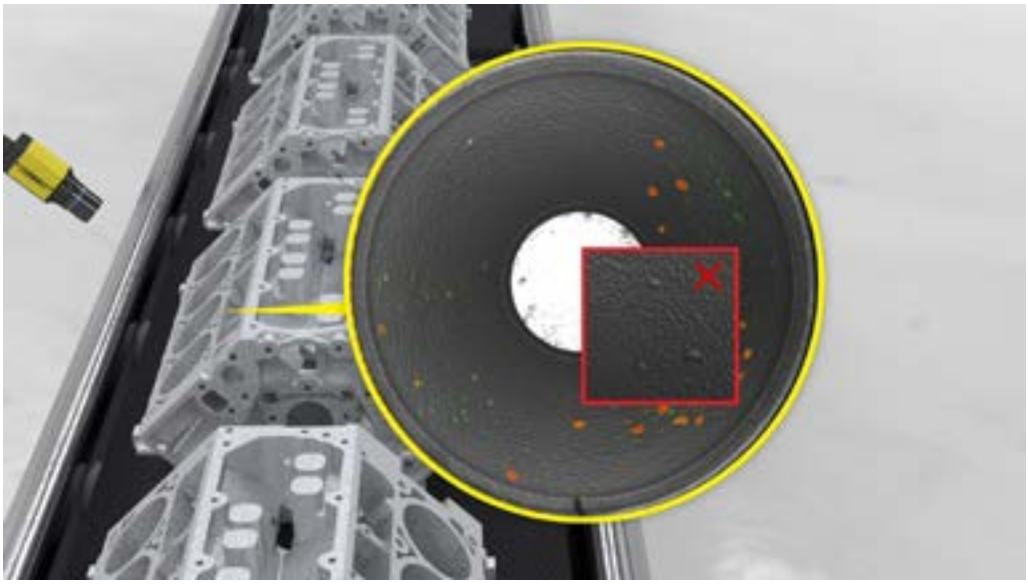
CHALLENGE

The cylinder block is the foundation of an automotive engine. Its large cylinders are the primary working parts of a reciprocating engine, built to hold the pistons as they pump up and down under compression. Cylinders are normally made of cast metal and are sometimes lined, or “sleeved,” in a lubricating coating. The cylinder walls must be durable as they make contact with a piston’s compression rings.

The cylinder can tolerate small irregularities in its metals, which are smoothed out during mechanical wear, but must not contain bubbles in the metal known as “pores.” These defects are especially challenging to inspect because a cylinder’s surface is rough, and images appear blurry around the edges due to the depth of field. Specular lighting, or glare, on the cylinder’s reflective surface also complicates the inspection. It is difficult to program an automated inspection that tolerates so many small variations in feature shape and location, as well as glare and blurriness.

SOLUTION

Cognex Deep Learning quickly identifies pores when other methods struggle to inspect under the same lighting conditions. Within minutes, an engineer can train the software on a representative set of “good” and “bad” images of a cylinder, adjusting the region of interest with a masking filter to eliminate the bright disk of negative space in the shaft. Using the defect detection tool in supervised mode, a technician annotates the pores in the images labeled as “bad” and adjusts parameters, including feature size, scale, aspect ratio, and shear to help the model account for variations in appearance. “Good” images which depict normal cylinders help the software learn which types of minor casting anomalies and variations are tolerable. The engineer can retrain the system, adjusting parameters and adding additional images, until the model can generalize the normal appearance of a cylinder and recognize the abnormalities. During run-time, the deep learning-based software inspects each image within milliseconds, characterizing those with pores as defective and the rest as normal.



Cognex Deep Learning distinguishes challenging defects on reflective cylinder blocks.

WELDING SEAM INSPECTION

Defect detection and classification tools simplify the automated inspection and classification of welding seam defects

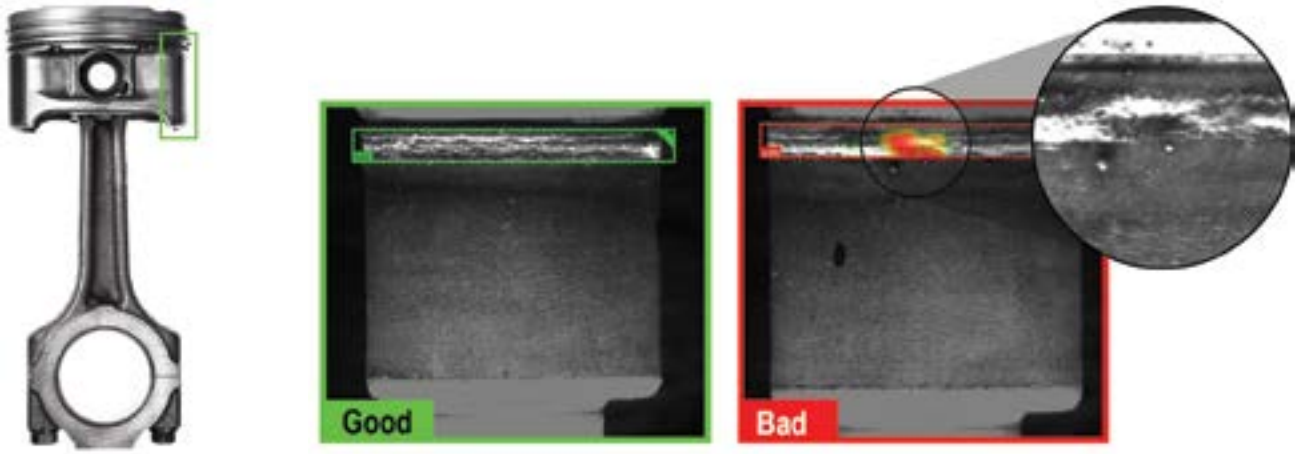
CHALLENGE

Cognex Deep Learning inspects the integrity of critical powertrain components like pistons, whose complex surface texture make traditional machine vision inspections difficult. A piston's welding seams are highly variable, making abnormalities difficult to distinguish. Certain welding anomalies, like missing, overpowered, or underpowered welds, are unwanted. Other anomalies, like overlapping seams, are desirable and required for safety reasons. Dark image areas introduce additional complications. Given the many possible flaws and lighting challenges, deep learning-based analysis offers a simple and robust alternative to traditional machine vision inspection.

SOLUTION

With Cognex Deep Learning the automated analysis of metal piston welding seams becomes simple. The engineer trains the software with the defect detection tool in supervised mode on a set of "bad" images representing all welding anomalies, including overlapping seams, and on "good" samples without any anomalies. In this way, all anomalies—both those that are desired as well as those that are a cause for rejection—are identified as defects.

In the second part of the inspection, the engineer uses the classification tool to classify seam defects by type. Based on the model developed during supervision, the software extracts information about specific defects and separates overlapping seams into their own class. By using these tools together, the automotive manufacturer is assured that the inspection system identifies all welding seams and successfully classifies the overlapping seams. Based on this information, the manufacturer is able to select only the overlapping seams for use.



The defect detection tool finds welding anomalies, then the classification tool separates them into useable or unuseable types.

SPARK PLUG IDENTIFICATION AND CLASSIFICATION

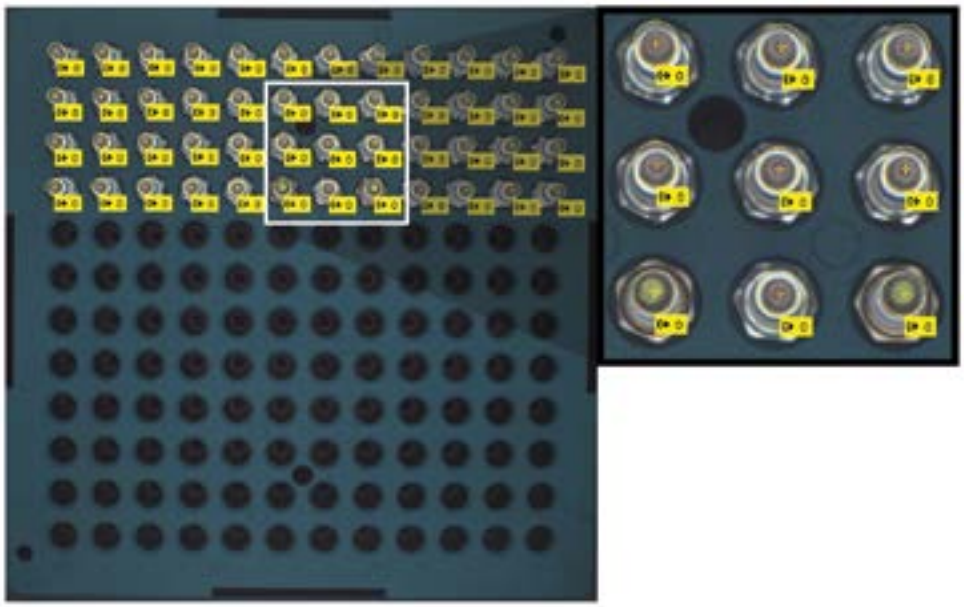
The assembly verification and classification tools identify, count, and classify parts based on their appearance for kitting/pre-assembly verification

CHALLENGE

For certain identification, counting, and classification applications, manufacturers must rely upon visual inspection when their environments do not support barcode reading technology. Slight variations in appearance can cause complications for an automated inspection system. This is the case for spark plugs, which arrive for pre-assembly on differently colored trays. The inspection system must successfully identify, count, and classify differently colored spark plugs while ignoring the background color of their trays. This information is then communicated to a vision-guided robot for assembly.

SOLUTION

Cognex Deep Learning generalizes the distinguishing features of a spark plug based on its size, shape, and surface features. With the assembly verification tool, an engineer fixtures tray images, teaching the software to identify and count individual spark plugs. The classification tool uses the deep learning-based model to classify the spark plugs by the feature germane to the robot—its color.



Cognex Deep Learning finds the position of spark plugs in trays and sorts them by color.

AIRBAG INSPECTION

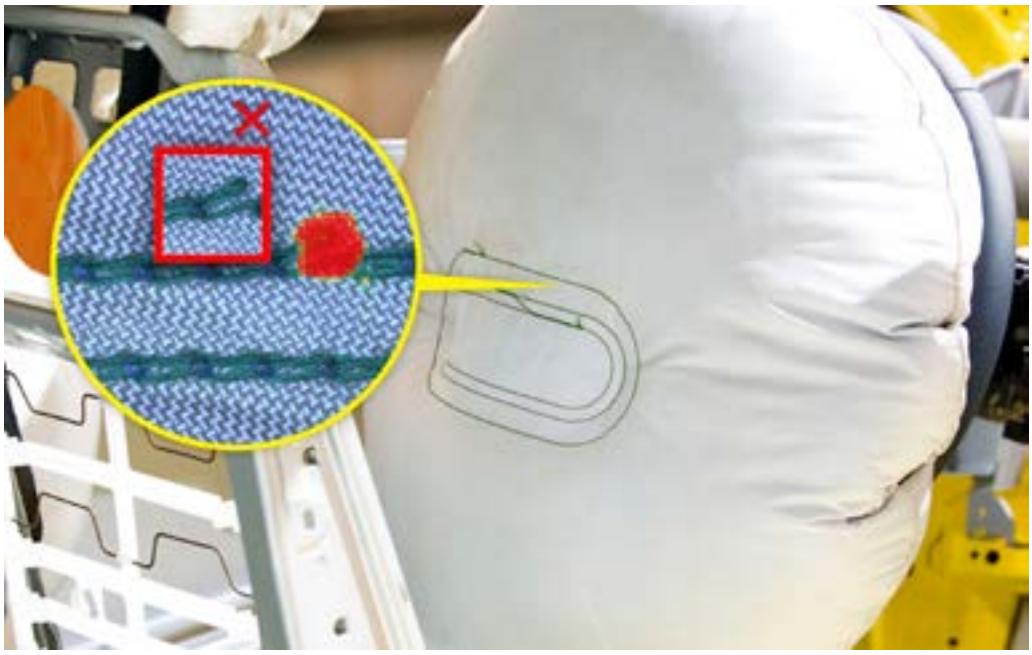
Defect detection tool inspects textiles for cosmetic defects

CHALLENGE

Airbags are subject to strict quality standards to ensure passenger safety. Automotive manufacturers must double and triple check all safety-critical components to ensure quality, decrease warranty costs, and reduce recall liability. This is especially important for airbags, which must be inspected for holes, rips, tears, and seam and stitching issues that could cause them to fail. These kinds of quality issues are often missed or hard to detect in manual inspection. They are also difficult to program into a traditional machine vision system because of an airbag's complex textile surface. The fabric pattern can be highly complex, and the visual appearance between airbags varies drastically due to the stretchable nature of the fabric, yarn thickness, and countless small tolerable variations. Because explicitly searching for all defects is too complicated and time consuming, Cognex Deep Learning offers a simple solution to identify all anomalous features, without training on "bad" images.

SOLUTION

An engineer uses the defect detection tool in unsupervised mode to train the software on a set of "good" airbag images to build a reference model of an airbag. The model learns the normal appearance of an airbag's fabric, including weaving pattern, fabric properties, and color. All features that deviate from the model's normal appearance are characterized as anomalous. In this way, Cognex Deep Learning reliably and consistently detects all anomalies, such as holes, rips, tears, and unusual stitch patterns. Defective areas of the fabric can quickly be identified and reported without the need for extensive defect libraries.



Cognex Deep Learning detects all types of manufacturing anomalies in airbag fabric.

TRIM FINAL ASSEMBLY VERIFICATION

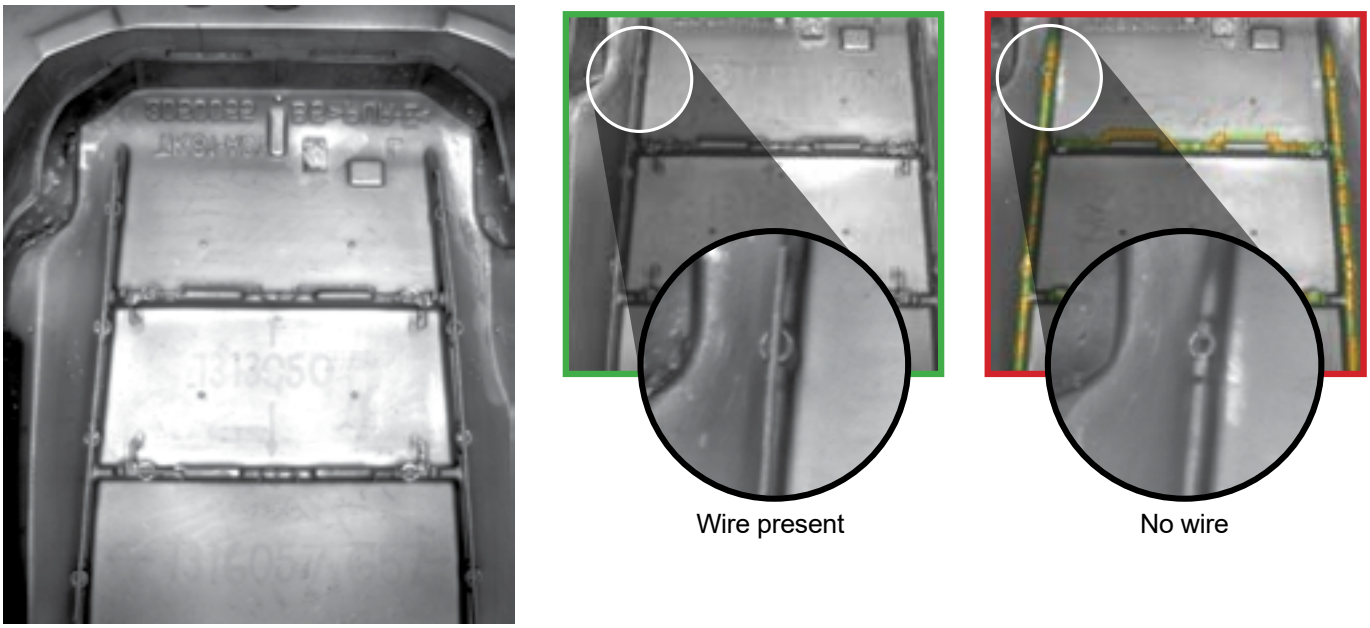
The defect detection tool confirms the presence and placement of components on a confusing background

CHALLENGE

The various pieces of trim involved in final assembly verification introduce a high degree of complexity that challenges traditional machine vision inspections. Human inspectors verify that all parts, such as wire bands and metal housing, are present and correctly assembled. Subtle lighting contrasts make it difficult to tell whether the bands are in their correct housing. Human inspectors, though skilled at identifying wire bands, are slow and inefficient. Cognex Deep Learning uses deep learning-based image analysis to learn the finished appearance of a piece of trim and identify missing bands as accurately as a human inspector, but with the speed and reliability of an automated system.

SOLUTION

Using the defect detection tool in supervised mode, a technician trains the system on “bad” images of trim where the wire is absent, as well as known “good” images where the wire is present, to create a reference model for a complete piece of trim. Using this model, the application identifies trim pieces with missing wire bands as anomalous and defective, failing them during final inspection.



Cognex Deep Learning identifies missing wire trim in a visually confusing setting.

VEHICLE IDENTIFICATION NUMBER (VIN) CODE INSPECTION

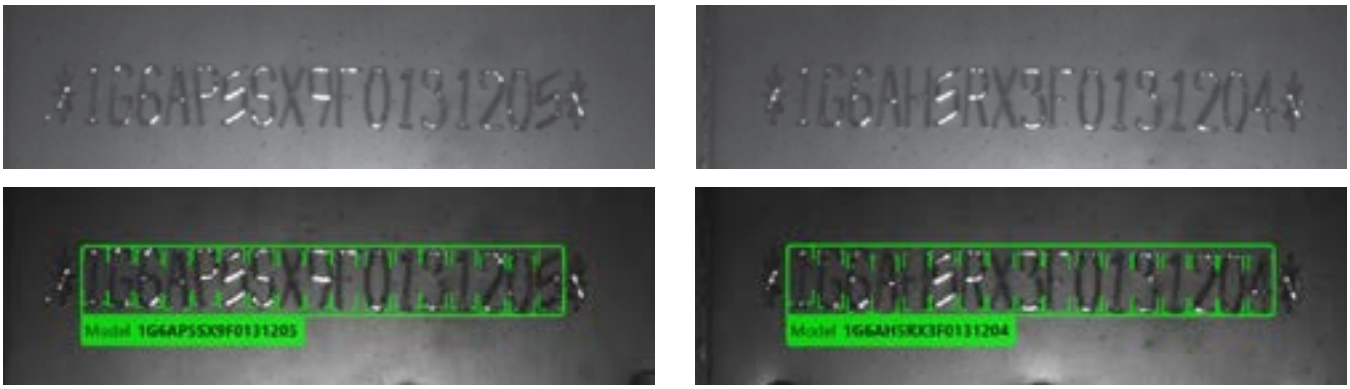
The OCR tool recognizes deformed characters

CHALLENGE

A vehicle identification number, or VIN code, is a multi-character code used as a unique identifier for automobiles. VIN codes contain letters and numbers and may be a direct part-marked (DPM); etched or scribed onto a metal plate; or printed on a sticker. Automotive manufacturers must be able to locate and decode VIN codes for successful traceability. Specular light, paint colors, and glare make it difficult for a machine vision system to locate and recognize characters. An inspection system needs to tolerate reflective surfaces which challenge image formation in order to successfully decode characters.

SOLUTION

With the OCR tool, it is now easy to locate and read deformed characters, despite image formation challenges. To train the software, an engineer defines the region of interest on images which contain a representative set of VIN code characters. The tool's pre-trained omni-font capabilities recognize characters even if they are obscured by glare and contrast. During training and validation, a technician re-labels only the missed characters until the software's model correctly identifies all characters. This new deep learning-based approach to OCR saves time during training and development by reducing excessive labeling and successfully reads characters on very noisy backgrounds.



Cognex Deep Learning recognizes deformed VIN code characters despite image formation issues.

COGNEX DEEP LEARNING SOLUTIONS

Cognex Deep Learning optimizes productivity by leveraging state-of-the-art technology based on field-tested, industry-proven machine learning algorithms. Rather than following a rule-based approach to solving inspection challenges, like traditional machine vision, Cognex's deep learning solutions learn to spot patterns and anomalies from reference images. 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

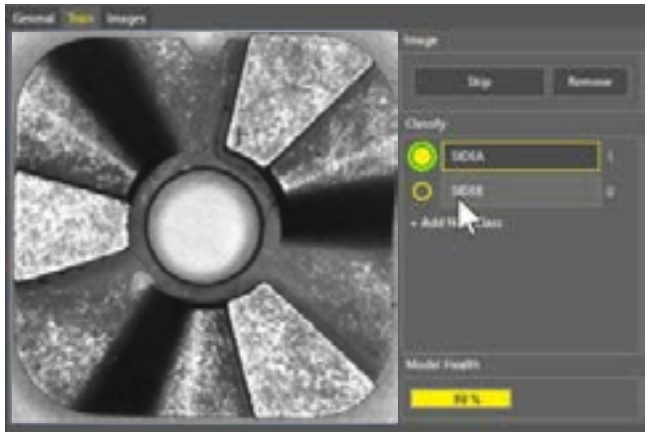
Simplify complex applications

In-Sight® ViDi™ deep learning tools are deployed on the In-Sight D900 smart camera without the need for a PC. The tools are trained using the familiar and easy-to-use In-Sight software platform, which simplifies application development, expedites factory integration, and delivers the power of deep learning to non-vision experts.

ViDi EL

Deploy reliable automation in minutes

Using a pre-trained set of powerful deep learning algorithms, ViDi EL tools automate complex tasks, like advanced segmentation and multi-class classification, quickly and reliably. The tools can be trained in minutes, using a few as five to ten images, with no coding required. This, plus an intuitive graphical user interface and a fast, easy workflow, make ViDi EL tools accessible to a range of skill levels.



VisionPro Deep Learning

Easily solve tasks — no programming needed

For more challenging inspections, VisionPro Deep Learning software combines a comprehensive machine vision tool library with advanced deep learning tools inside a common deployment framework. It streamlines development of highly variable vision applications and allows engineers to build flexible, highly customized solutions tailored to their specific requirements, all without the need for complex programming.

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 common to complex tasks.

www.cognex.com/machine-vision

3D VISION SYSTEMS

Cognex laser profilers and area scan 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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