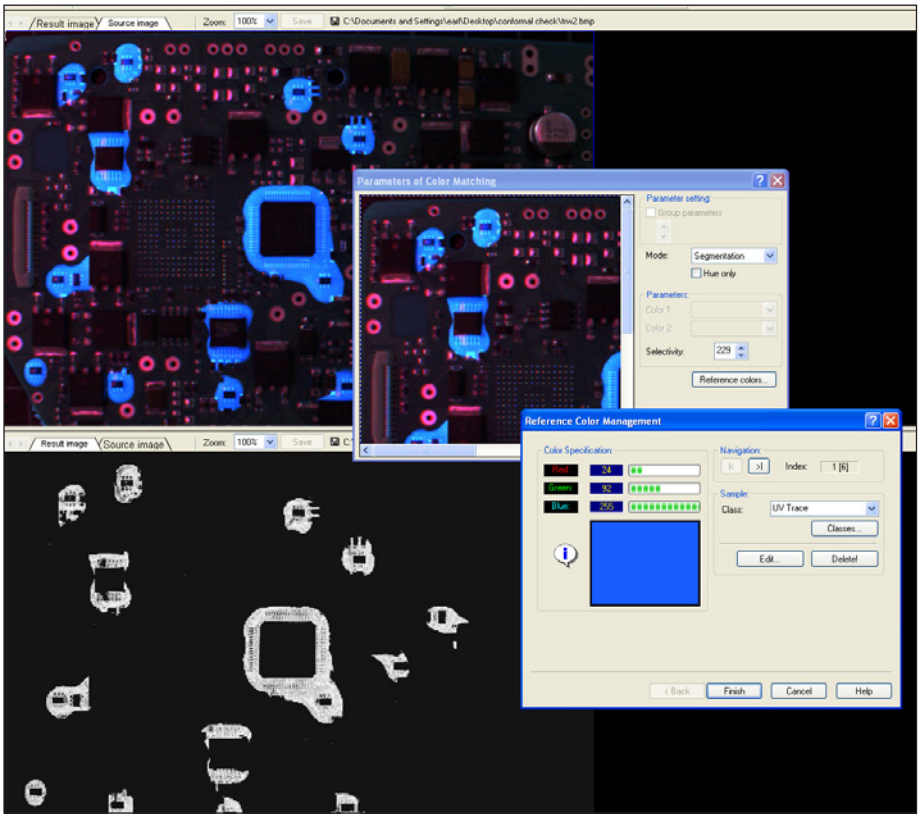
INDUSTRIAL VISION SYSTEMS LTD

Case study

Machine vision inspects protective PCB coatings

Industrial Vision Systems Ltd provides systems for the automatic inspection of conformal coats for electronics manufacturers.



Conformal coatings are protective, dielectric materials designed to conform to the surface of an assembled PCB. Commonly used conformal coatings include silicone, acrylic, urethane, and epoxy. While these coatings protect circuitry from moisture, fungus, dust and corrosion, they also prevent damage from board handling during construction, installation and use, reduce mechanical stress on components and protect them from thermal shock. Designed to resist abrasion, these coatings also minimize the electro-migration of metal between conductors.

In the fabrication of PCBs, electronics manufacturers apply such coatings using automated systems that consist of an X-Y-Z platform that moves a dispensing head to key points on the surface, in a process known as selective conformal coating.

To allow operators to manually inspect PCBs, many of the standard conformal coating materials are available with a 365-nm wave length UV trace. Using standard UV lamps, inspectors can then manually check individual boards to see if the coating is placed correctly around the component, whether it has migrated into incorrect areas of the board and whether the correct amount of coating has been applied.

Due to the different levels of trace versus raw material within the compound, the fluorescent nature of such coatings can vary widely. Because of this, inspectors must be properly trained to understand the nature of both the compound used and its fluorescent properties to properly inspect each board. As with all manual inspections, such checks are subject to the individual accuracy and reliability of each operator.

Because of this, one large UK-based OEM manufacturer of PCBs approached Industrial Vision Systems (IVS) to automate the process of inspecting these coatings. IVS designs and manufactures machine vision systems for industries in the automotive, pharmaceutical, and printing as well as the electronics industry.

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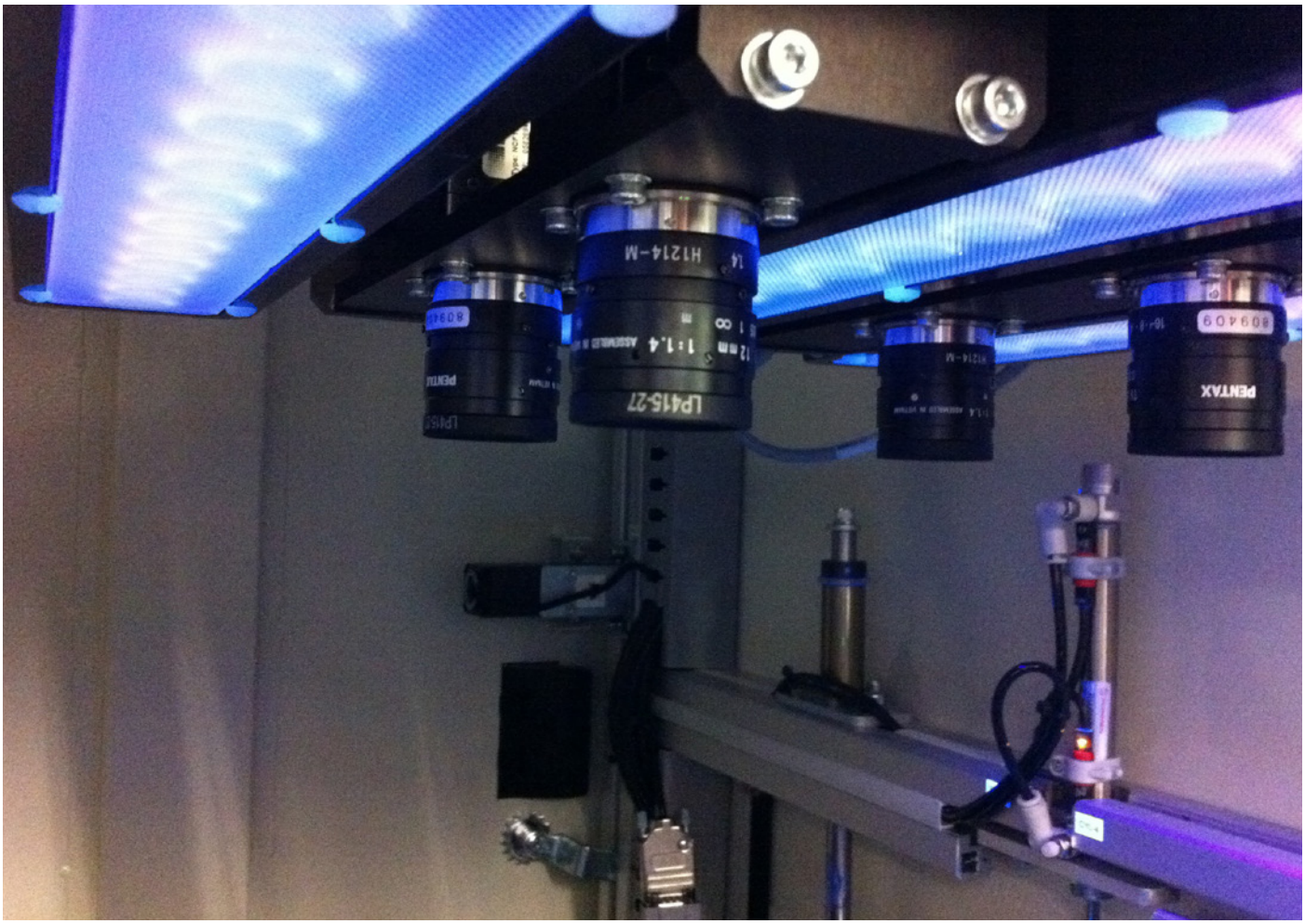
UV inspection

In the design of its conformal coating checking system, IVS chose a standard 1000mm PCB conveyor system and canopy. In this way, the system can be adapted for any size of board and multiple PCB types. Under control of a Micrologix PLC, PCBs are individually stepped along the systems conveyor and into the inspection station using the SMEMA standard machine interface. This equipment interface specification standardizes the communication mechanism for single transfer manufacturing systems of surface-mounted PCBs and allows equipment from a number of different manufacturers to be integrated more easily.

Because of the nature of the UV traces added to the conformal coating, no off-the-shelf UV lighting could be used to properly illuminate the board. Because of this, IVS built two custom industrial lighting rigs to illuminate both sides of the PCB. To image each board, two NCF113c 1392 x 1040 FireWire cameras from IVS were mounted above and below the conveyor belt. Digitized images were then captured using an industrial PC interfaced to the system's PLC.

Three separate checks must be made on each PCB. The first, called UV Trace Runout ensures that that no conformal material has deviated into any other no-go area of the board. The second, UV Trace on Component, determines if the coating is in the correct position around the component and that the correct amount of material has been used. Finally, a RGB Color Match checks whether the color level of the coating is within specification and that the material has been mixed correctly. To perform these inspections, the host PC runs the IVS machine vision software.

To check whether the conformal material is in the correct position on the board, captured images are first contrast enhanced using a software-based look-up table (LUT). Defined regions of interest (ROIs) are then determined from a known good template of the board. Because the amount of coating that can be tolerated in any specific region of the board is known, the regions of interest can then be highlighted by thresholding the image and counting the number of pixels within each. In a similar manner, the software can be programmed to determine the correct position and amount of coating.



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Color levels

To compute the color level of each coating, the UV trace within each ROI is color matched using IVS's Color Matching Wizard. Each color value is represented by three values for the three basic colors of Red, Green and Blue. These values fall into the standard gray level range from 0 to 255.

Taking an RGB color image as input, the software creates a gray level image of the same size as its input image. The gray level of every pixel in this image indicates the similarity of the corresponding pixel in the original image to one or more known reference colors.

In the design of the IVS system, the Distance Mode function of IVS was used. In this mode, the brightness of the resulting gray level pixel indicates its similarity to a single reference color. For each pixel in the source image, the similarity of its color to the reference color is computed. The gray level of the corresponding pixel in the result image indicates the degree of similarity. A similarity below the required selectivity value is coded as black. A similarity of 1.0, which means that the pixel has exactly the reference color, is coded as white.

By using color FireWire cameras with this software, the RGB settings of the camera can be dynamically changed during the inspection process, allowing the system to compensate for the varying levels in UV trace within the material.

After each board is inspected, the system's host PC uses the pass/fail data to trigger the Mirologix PLC using a 32-bit digital I/O card. Should a board fail inspection, a reject mechanism can be triggered to eject the board from the conveyor system so that it can be returned for any necessary rework.

Human interface

To supply the system's operator with information regarding each PCB inspection, IVS developed a graphical user interface to display images and the results of each inspection. As each board is inspected, the operator is presented with an image of the board and the highlighted ROIs. The results of each pass or fail on each board is displayed as well as a running total of the number of boards inspected and passed by the software.

Because such information is stored in a standard database format, it can be networked to existing database systems to provide management about the integrity of each system in the PCB production process. This information can be transferred from the system's PC using a standard Ethernet interface.

While color algorithms such as those developed by IVS can check for specific placement, position and conformal coating integrity, they can also be used in other applications to locate fiducial marks in other parts inspection applications. Rather than use template matching algorithms, the use of such a color-based algorithm could locate and then reposition products for further inspection. Alternatively, they could also be used to perform a pure color matching function in print inspection applications where a correct color hue or intensity must be correctly maintained.

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