

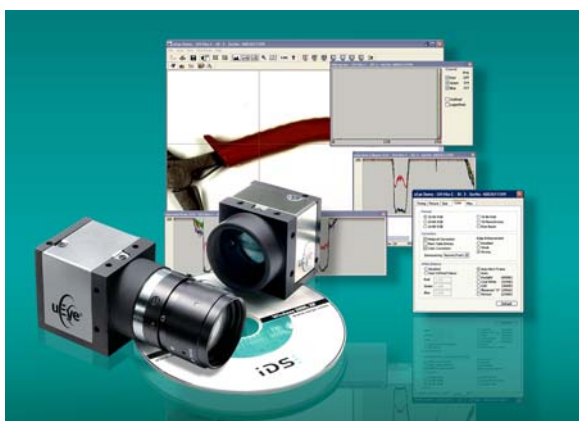
## A Brilliant Solution

### Defect Detection in Reflective Surfaces with USB 2.0 Industrial Cameras



Industrial image processing systems have become indispensable in many areas of modern quality assurance. Whether in end-of-line inspection or robot control, machine vision today ensures fast, reliable and objective quality control as well as in-process defect detection. With brilliant high-gloss surfaces, however, automated image processing has so far come up against its limits: Where standard test methods using direct light or transmitted light fail, it is up to the human eye to identify inclusions or deviations in color or texture. The VisionFlex image processing system uses a new process which now allows inspecting the quality of high-gloss and reflective surfaces with modern machine vision components. A high-resolution industrial camera with USB2.0 interface plays an important part in this context.

When inspecting surfaces for defects or imperfections, the human eye has capabilities that no machine yet can match. Despite this fact, automated inspection currently is employed whenever possible. The advantages are clear: Besides economic efficiency, it offers maximum repeatability and objectivity. A high evaluation speed and the possibility of integrating the inspection procedure directly into the production process are further reasons in favour of automated image processing.



Machine-based surface inspection methods have until now checked the visual quality by means of direct or transmitted light in conjunction with a camera system. When it comes to the automated inspection of reflective and smooth surfaces, however, these methods involve problems. The resulting reflections need to be either eliminated or included in the measuring process. Consequently, complex

lighting conditions using polarized light or fringed projection in a darkroom are required, or the objects need to be positioned with high precision and completely shock-free. Whichever solution is employed, neither permits an automated 100% in-process inspection.

Software technology can help, but involves an excessive amount of computation. This in turn considerably slows down the inspection process and thus the production cycle. The quality of brilliant high-gloss surfaces is therefore inspected by eye and only by random sampling, be it in the automotive industry, in the manufacture of sanitary and kitchenware, in CD and DVD production, or in the glass-processing industry.

The German company ELCO-PRO GmbH & Co. KG in Dortmund decided to take up this problem in cooperation with the University of Karlsruhe. The solution they developed allows the non-contact quality control of reflective or high-gloss parts by 100% in-process inspection. This means that inspection can be performed at the speed of the production run and is largely unaffected by position changes, shock or extraneous light.

VisionFlex employs the so-called deflectometry method, a newly developed procedure which is based on standard components and is thus cost-effective to implement. To avoid all the previous difficulties with reflective surfaces, different

intensity patterns are projected onto the surface to be inspected. The patterns are mirrored—on flat projection walls for nearly flat surfaces and on hemispherical ones for curved surfaces—and recorded with an industrial camera. By evaluating pattern deviations in the images, the system can then locate possible defects and imperfections. Stored reference samples can also be included in the test.

The VisionFlex system from ELCO-PRO is based on the HALCON image processing software and on a USB2.0 industrial camera of the uEye® family from IDS Imaging Development Systems. IDS has been one of the first manufacturers to focus on the consistent use of the fast and convenient USB interface as the connection solution for industrial cameras. The South-German machine vision specialist today offers over 40 different models with CMOS or CCD sensors. ELCO-PRO's application uses a UI-1440-M (1280 x 1024 pixels, CMOS, monochrome) which, like all cameras of the uEye® family, provides a very compact design, fast frame refresh rates and excellent software integration.

The camera series, whose smallest model is only 34 x 32 x 27.4 mm in size, offers advanced performance. At a resolution of up to 5 mega pixels, the "minis" achieve a frame refresh rate of up to 75 frames per seconds in full-frame mode. Far higher frame refresh rates are possible in the Area-of Interest mode (AOI).



Cutting-edge features such as windowing, binning, subsampling and image mirroring in the x and y directions complement the scope of

functions. Thanks to the USB 2.0 interface, the camera does not need any additional hardware and can be connected immediately to any laptop or PC. Whether it's varnish, chrome, mirror, glass or plastic—the more reflective the surface is, the more apparent the capabilities of VisionFlex become. It reliably detects dents, bumps, inclusions, scratches, pimples and pits in specimens from 5 to 5000 mm. Polishing defects and striae can also be identified and displayed on the screen. The system additionally tells a defect from a speck of dust or other contamination. Accuracy is in the  $\mu\text{m}$  range without requiring special light conditions.

Image evaluation with VisionFlex is performed using the proven HALCON image processing software. This software combines the advantages of a flexible architecture with the possibility of quickly developing a vast variety of image processing and analysis applications. The uEye camera provides the corresponding interface to HALCON as well as to many other standard machine vision programs, such as ActivVisionTools, Common Vision Blox or NeuroCheck. A TWAIN driver, an ActiveX component and a WDM are also available for the users of standard software solutions. This excellent software support ensures fast and easy integration into applications.

All uEye cameras support the current Windows operating systems as well as Linux. Each camera comes with a free software package comprising a software development kit (SDK) and demonstration programs for image recording and analysis. The corresponding source code written in C/C++ is also supplied to permit quick customization to the individual requirements as well as smooth integration into the application. The SDK allows control of all camera-related parameters and provides memory management with ring-buffer and double-buffer administration. It also offers a direct draw interface, with which a non-flicker insertion of individual information (e.g. date, time, graphics) in the live video can be achieved.

The consistent use of standard components makes VisionFlex a flexible, low-cost inspection system. It has succeeded in replacing the human eye, which cannot keep up with the speed of the production process and also quickly tires, in the inspection of reflective and high-gloss surfaces. As an automated 100% in-process inspection system, VisionFlex meets exigent quality requirements. It ensures the early detection of systematic defects and thus substantially reduces the reject rate as well as the need for rework.

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