AOI System with Frame Grabbers and FPGA Applet from Silicon Software

Delvitech from Switzerland offers automatic optical inspection (AOI) to prevent process errors, increase the yield and reduce the costs in the manufacturing of assembled printed circuit boards (PCB). The core element of these systems is an optical head consisting of five cameras and various side-mounted illuminations. The company recently developed a new head upgrade for its AOI systems installed in the market, with more powerful cameras and frame grabbers – and is now benefiting of important sales, offering solutions significantly better with higher speed, improved detectability and greater flexibility.

Delvitech needed new cameras for the optical head, as the existing ones lagged behind the desired high image quality. The cameras had to achieve a higher resolution, have suitable interfaces to the new frame grabbers and acquire at least 30 frames per second. For the scalability of the system, the interchangeability of cameras and frame grabbers was an important requirement, independent of the camera interface and without changing the image processing software developed in-house.

In the optical head there are a camera at the top and four cameras at the side together with 24 xenon light sources, 4 RGB leds and a special sensor. A monochrome CMOS area scan camera 25 Mpixel with CoaXPress interface was selected for the upper camera instead of the previous 4 MP resolution camera. Four monochrome Camera Link Basler ace CMOS with 4 MP resolution and 180 frames per second are now used for the side cameras replacing the previous analog ones. The upper camera has a larger sensor so that fine features can be better resolved or the same level of performance can be maintained at a higher throughput. Due to the also larger sensors of the side cameras, discrepancies in the resolution between all cameras are reduced. The selected cameras are dimensioned to run below their potential performance and therefore allow the performance of the system to be enhanced at a later stage.

In order to connect them to the software, the project partners jointly developed image acquisition functions as a hardware applet using the FPGA development environment VisualApplets from Silicon Software with the advantage that the frame grabbers, already during the image transfer, always generate the same output format. This means that the software can be easily further used when changing cameras, frame grabbers or the camera interface. The applet was designed as a data flow model and synthesized as FPGA code for the runtime environment on the frame grabber. The overall implementation of hardware, software and applet was completed within a few days. “We owe the short development time to Silicon Software’s extraordinary consulting competence and operational readiness. On the basis of only two coaching sessions the design-in could be completed entirely,” explains Roberto Gatti, VP Sales and Marketing of Delvitech.

Scalability and Great Flexibility

The disadvantage of the frame grabbers used so far was that they were only suitable for special cameras and were incompatible with the new high performance cameras selected, the intended light sources and the self-developed software based on algorithms with artificial intelligence. Therefore Delvitech chose two different programmable frame grabbers from Silicon Software, both compatible with diverse cameras and lighting as well as the software. The upper camera, four side cameras and the lighting are synchronized by the microEnable 5 VCX-QP CoaXPress frame grabber, while the up to four side cameras are triggered by two Camera Link frame grabbers microEnable 5 VCL. With the system upgrade, Delvitech also switched to the very powerful 64bit D.ONE Core.

The system was designed for scalability with the use of one standard camera up to five high-end cameras in the highest expansion stage, which the frame grabbers support. In order to connect them to the software, the project partners jointly developed image acquisition functions as a hardware applet using the FPGA development environment VisualApplets from Silicon Software with the advantage that the frame grabbers, already during the image transfer, always generate the same output format. This means that the software can be easily further used when changing cameras, frame grabbers or the camera interface. The applet was designed as a data flow model and synthesized as FPGA code for the runtime environment on the frame grabber. The overall implementation of hardware, software and applet was completed within a few days. “We owe the short development time to Silicon Software’s extraordinary consulting competence and operational readiness. On the basis of only two coaching sessions the design-in could be completed entirely,” explains Roberto Gatti, VP Sales and Marketing of Delvitech.
High-Quality Software Included

When inspecting assembled printed circuit boards, the AOI system on the one hand checks the presence, absence, the polarity, the names, the colors, the polarities, and the correct positioning of the components. On the other hand, it inspects the shape of the solder joints by their form detecting opens, shorts, cold solder joints and any type of defects related to wrong solder joints on reflow and wave applications. For this purpose, a part of the printed circuit board is illuminated according to the specifications of the software using RGB led, whereupon one or more cameras trigger and take images with color reflection. This creates one or more images from different angles, whose colors are later reconstructed using the Delvitech software. The frame grabbers synchronize the triggering of the cameras and the numerous light sources via a flash controller. After image acquisition, the images are corrected by the software in the course of image pre-processing, for example their orientation.

The AOI image processing system with the optical head is used in production plants. Due to the now given higher camera resolution, it achieves significantly better measurement results at four times the speed and higher frame rate. This means that considerably more examinations of printed circuit boards can be carried out per minute – at the same cost of the overall system. The system now processes images in just half a second, from acquisition and image pre-processing to merging and comparing the images, analyzing them and outputting the results. “The components can be flexibly exchanged and scaled regardless of the camera model and interface, and the system can be easily adapted to new customer requirements thanks to the accompanying applet,” states Gatti. In order to meet these requirements in the future, an extension of the system to 3D inspection with stereo vision is planned, which would further optimize the system.