Getting a closer look at production defects

A UK company has developed an intelligent vision system that detects structural surface and colour defects to whatever level the user requires. Dean Palmer reports

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- The vision system combines high defect detection sensitivity over a potentially vast range of product styles, whilst at the same time 'classifying out' non-defect features
- This is achieved through the use of self-training and self-organising tools
- To achieve high sensitivity, the system uses MMX/SSE2 technology and optimised Pentium 4 code in all of its processes
- The system also uses special, in-house algorithms to detect faint but visible angled line faults, common in web inspection applications

A next-generation vision system has been developed that is able to find structural surface defects and colour faults to whatever level customers require for their manufacturing process.

The 'webSpector' imaging machine, developed by Shelton Vision Systems based in Leicester, has an in-built self-training system that is capable of teaching itself to find errors and reporting them to production. And, the system's innovative 'webCorder' enables the entire set up test run to be played back, which, according to Shelton's director Mark Shelton, results in "faster, more accurate set up and reduced scrap."

He explained further: "It uses a combination of powerful, off-the-shelf server grade PC technology with flexible software architecture and top-end digital imaging technology, to provide users with a scalable system for finding surface and colour defects. All the hardware is replaceable and upgradeable and the system has been applied in harsh environments too."

WebSpector is a potential solution to a common problem faced by manufacturers of high volume, highly diverse products who also have high fault detection requirements. Finding a vision system that can actually cope with this type of production process is difficult. Shelton explained: "Many firms require high sensitivity for defects with similar or even lower contrast, but that are visible due to their spatial differences. The fabrics are of high quality, with detection accuracy and low false alarm rates critical to maintaining production yield.

"Other manufacturers have a very large defect range of different sizes, shapes, orientations and contrasts, as well as large product ranges. One customer of ours has 1,500 different products, with new styles being introduced frequently. The other issue you have with installing a vision system in-process, is that non-permanent defect-like features can occur on the material which need to be ignored. You don't want to stop the production line for these."

WebSpector is built on PC-based processing modules because of their rapid development and powerful Pentium 4 MMX/SSE2 instruction sets, which are very suitable for 8-bit image processing. Normally, there is a central PC that interfaces to the factory and which controls all the other PCs that work in the background and are connected to one or more line-scan CCD cameras.

Shelton's vision system (left) in operation at a textile manufacturing plant

Filtering out non-defects

The central PC also performs defect classification, report presentation and other user interface tasks. For fabric inspection, there are typically three camera imaging planes, one lit from above the material or fabric, one from behind and one at the low angle to the top surface. The system combines the information from the three imaging planes to help it make decisions as to what each defect type is, which in turn, enable it to filter out features that are not considered defects. Each defect has up to 66 properties extracted to help identify it.

Shelton developed the original webSpector system in 1999, primarily for the woven and non-woven textiles industry, but the system is equally suitable for inspecting aluminium, steel, plastic, rubber, laminated materials, composites, coated materials and technical textiles. With the colour module, the system can also detect the relative change between two colours to better than one delta E (ie. better than the human eye).

Shelton's system approach to solving the "high product range/high defect sensitivity" problem is patent-pending and involves the combination of three separate ideas into the overall vision system. They are 'webCorder', 'webGrouper' and 'webTrainer'.

Dr Millman, development engineer at Shelton explained: "When dealing with such a large range of styles, typical in textile applications, it is impractical to carefully train each one manually to the necessary standard. Hence, the styles need grouping to a controlled extent. This is the function of the webGrouper, which automatically groups each style based on information passed to it from the webTrainer. It can also create new groups if a new style cannot be contained within the existing groups."

Millman described webTrainer as the "workhorse" of the system. He said that webTrainer can take any product and automatically train all 51 separate defect detection algorithms to a required sensitivity standard in an unsupervised mode. "It does this by assuming that most of what it sees is good material, but then filters out that which is suspect. To accommodate existing client quality requirements and knowledge, webTrainer has optional individual settings per group where it will be 'more' or 'less' sensitive depending on database settings. Therefore, each product is individually auto-trained but shares general sensitivity and classification requirements with its parent group. The webTrainer and webGrouper enable webSpector to work as a powerful vision system almost immediately on material it has never seen before."

The webCorder enables the entire sheet of material to be recorded to disk at production speeds, so that it can be replayed later. This means quality staff can 'skip' to any part of the process very quickly. As Millman: "For quality critical applications, it is used to help validate a group, in that results for a newly-created group can be compared with manual inspection results. If a defect is missed by the system, webCorder can be moved to that point and its settings adjusted so the defect is reliably detected.

"The physical material does not need to be re-run through the system, which after a few more goes would probably induce many more defects than there were to begin with. This saves time and scrap and allows good verification of system performance."

Customers using the system are reaping the rewards. WL Gore and Associates, for example, based in Livingston, Scotland, manufactures high performance PTFE membranes and fabrics for a variety of end uses, from guitar strings to special uniforms for the MoD. Stuart Speake, associate and (vision) system champion at the firm, commented: "The system teaches itself and this has drastically reduced the time to train and validate a new product. We allow it to self-train itself until it has reached a level that is appropriate for our requirements. We have thousands of different styles, which have to be set up to run. Without the tools provided by WebSpector, it would be a mammoth task to introduce new products. The software is user-friendly and the fault tracking and statistics generator are useful as they allow us to control quality tightly. The error mapping allows us to analyse exactly what's happening in production – it takes out subjective-ness and de-skills the process."

To date, Shelton has sold eight webSpector vision systems. Overall system cost varies from £40k to £350k for more sophisticated systems but Shelton can also offer clients a 'live support' package where it inspects a machine over a secure network. The firm demonstrated this to *Eureka* via a live link to a fibreglass production line at Owens Corning Veil, a plant where material was passing the vision system at 170m/min. The system was installed by Shelton in 2001. Defects could be measured down to 0.5mm.

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Shelton Vision Enter 550