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REALISING YOUR QUALITY VISION WITH VISION

Shelton Vision Systems Ltd, based in Leicester, has developed a range of vision inspection machines capable of finding structural surface and colour variation faults. The webSpector®, Shelton's latest innovation, is a scaleable system that can be installed as a basic unit and upgraded as process requirements dictate. The primary functions of the system are to improve quality giving the paybacks of reduced cost and increased customer satisfaction.

Shelton's technology has its roots in a collaboration project with Loughborough University. The initial Loughborough University and Shelton research has been further developed by Shelton's post-doctoral engineers leading to a number of state-of-the-art PC based machine vision systems. The main benefit of the Shelton systems is the incorporation of a dedicated inspection platform using off-the-shelf, PC technology.

The Shelton systems offer a quick return on investment and have been applied across a number of diverse industries, such as: fibreglass veil, laminating lines,

lithographic coil facilities, wallpaper production, tyre manufacture and in textile manufacturing facilities. Particularly useful is their ability to operate in harsh environments providing the manufacturers with on-line inspection where the production process would normally have to be stopped.

The Shelton webSPECTOR® family of machine vision products can tackle a wide range of inspection tasks that until now have required bespoke engineering. The webSPECTOR® range breaks inspection tasks or requirements into three groupings:

- Tasks such as gauging, location and measurement where the objects being studied have a pattern or profile to match against are covered by the WebSPECTOR® Lite system.
- Fault detection tasks involving unknown data are covered by the WebSPECTOR® Standard system.
- Tasks requiring increased functionality such as data-base management, defect libraries and self-training are included in the webSPECTOR® Plus system.

Each of the above systems form the basis for a custom engineered solution, which is scaled to suit the mechanical size and resolution of the task being undertaken.

Traditionally inspection is performed by inspectors on the production line, or samples of the materials being inspected are taken off-line for inspection. If samples are taken off-line, it can be some time before the results are known, allowing further operations or quantities of product to be manufactured with faults. The time delay of the traditional approach can lead to high levels of reject with the economic consequences ultimately impacting on the profit margin and the selling price.

As with quality inspectors, an automated system needs to be trained to work to the parameters required by the quality department. Training an automated inspection system to find a fault depends very much on what is being inspected and for which market. An inconsistency that is a fault for one product or manufacturer may not be a fault for another. As a human inspector can use their judgement and tailor their criteria, then so can automated vision systems based on the webSPECTOR® family of products.

This training can be performed manually by an operator for each product type or code, and with the webSPECTOR® Plus the training can be performed automatically. Automatic training is facilitated by passing products through the system and allowing it to automatically set sensitivity levels relative to the

surfaces it is inspecting. The trainer uses a pre-determined criterion that takes into account customer wishes and manual inspection knowledge.

Whether the training is done manually or automatically, the parameter settings are recorded against the product type reference and can then be used for all subsequent occurrences of that product type. The result is that each instance of that fabric type is inspected to the same standard reference.

The faults and inconsistencies that may be encountered are many and varied. They will depend on the manufacturer and product type, ranging from small defects in the surface or texture, through to colour variations and on to the geometric structure of the product being inspected.

A great deal of information can be gleaned over the long term from data obtained by these types of system. WebSPECTOR® systems can store the information, including the images of the faults for later trend analysis. The information can be fed via an Ethernet directly to a computer quality system for six-sigma analysis.

A typical example is the inspection of fibreglass veil, where defects such as holes, clumped fibres, wrinkles, and contaminants tend to be created at the hydroformer end, or in the ovens. They can be as small as a half a millimetre running past the inspection system at up to 200 metres plus per minute. The contrast between a fault and the material may be relatively constant, as in white

fibreglass, or may vary as in a textile mill producing cloth from black through to white, with the faults being only a few tenths of a millimetre.

Owens Corning Veil, a fibreglass sheet manufacturer, has installed a Shelton system on the output of their curing line. The point of manufacture is a particularly hostile environment due to dust, heat and humidity. In addition, the production rate of 2.2 metre wide fabric, specified up to 200 metres per minute, means that any manual inspection would have to be done off-line.

In the past, the fibreglass was inspected manually. It would be batched and moved away from the production line for detailed inspection. The high output of this process meant the rolls were inspected on a sample basis. This, combined with varying concentration levels of an individual inspector, led to variations in the inspected quality of the output product.

Traditionally, rolls of fibreglass used to be removed from the end of the line and stored as work in progress prior to being inspected before being shipped to the customers. Any fault information, which required alterations to the process, could be several hours out of date. As a result, avoidable quantities of substandard product could be produced. Depending on the type of fault, the end result could be selling at a greatly reduced price with little margin, or at worst see the material being sent to landfill sites with the associated costs.

Owens Corning use the webSPECTOR® Plus system which is an automated machine vision system. It has led to consistent levels of inspection across the full width of the product at the point of manufacture for 100% of each production run. By feeding back inspection results at the point of manufacture, the system has also led to a significant cut down in waste as production alterations can be made in real time. More importantly, inspecting 100% of the material has also ensured that product quality specifications can be met on each roll. This is crucial for some of the end uses of the product, and was illustrated by the fact that the number of customer returns dropped substantially within the same year the inspection system was installed.

Vision systems can also give added value above simple inspection tasks. This is demonstrated at the Owens Corning plant where the system is being used to improve the production process. Commenting on this issue Subir Chandra, Manufacturing and Six Sigma - Black Belt - Engineer at Owens Corning, said, “The webSPECTOR® Plus system gives us early warning of production problems which we can rectify before wasting considerable amounts of raw materials. In particular, the recently introduced classification of the faults helps us to analyse the line conditions over time, and drive down waste even further.”

Subir went on, “The webSPECTOR gives us the defects data and the frequency of the defects with the location. This helps the Six Sigma practitioners to find the source with less effort. In the past, finding the source was a major exercise. We

would have to look everywhere and considered ourselves lucky if we found the source quickly. It would have depended on someone's excellent process observation.

We typically found a unique fibre clumping which the operators called snaky fibres. With the help of the webSPECTOR, we have been able to pinpoint where it is coming from. The information from the webSPECTOR allows us to take actions on the other end of the hydroformer machine to reduce these defects. "

Owens Corning further utilises the data produced by the webSPECTOR® Plus to assist customer relations, sending a roll map of all faults out with each roll dispatched to the customer. Customers know exactly what faults they are being sold and where they are located.

A similar approach has been used by W.L.Gore and Associates to inspect their vast range of textile PTFE laminate products, 'GoreTex'.

The difference between Owens Corning who produce several hundred product types of a similar type and that installed at W. L. Gore is the much larger range of products with which the webSPECTOR® Plus system is expected to deal (several thousand individual products). To cope with this the Shelton webSPECTOR® Plus system has an inbuilt self-training utility. This enables diverse and rapidly

developing or changing product ranges to be inspected to standards higher than human inspection, which would not otherwise be possible.

At W.L. Gore, new textile products are introduced all the time. Due to the large variation of defects, and the subtle contrast and spatial differences between many of the fabric faults and the background texture, there are around 50 independent fault detection processes employed within the system. Each of these needs to be set at the right sensitivity for each product. This would take too long for a system trainer to set up, particularly since some work orders are only a few hundred metres long, and may be not be produced often.

The webSPECTOR® system employs several automation related technologies to overcome this problem. The first is the webTrainer module that trains the system sensitivity settings on all products in an unsupervised fashion. When a product, never seen by the system is presented, the webTrainer trains the system on a first representative length of the material. It then inspects the remaining material, with markers to indicate where the inspection began.

The unsupervised training is achieved by assuming most of the material it sees is good product and then trains itself to expect that texture. Defects in the training length do not skew the training accuracy. During inspection, deviations from the normal appearance are then sent for further analysis by a classification module. As well as classifying the faults, this decides whether the anomalies are defects

or features to be ignored. It is possible to input current manual inspection knowledge into the auto training and classification modules, so that they can be more or less sensitive depending on customer wishes.

The second technology is the webCorder module. This is part of a concept designed to ensure the inspection system is operating as expected and is especially useful where quality is critical and there is little tolerance on faults. The entire web can be recorded at production speeds to disk. It can then be replayed as though the material were being run through the system again. During validation of the system's abilities for each application, the webCorder is used to compare manual and automatic inspection results. If the manual inspectors see a fault not seen by the system, the webCorder can be moved to this position and the inspection systems settings adjusted to ensure the fault is detected. These settings can then be incorporated into the auto-training module to ensure subsequent products are also inspected properly.

The webCorder is also useful in ensuring that false alarms, where the system sees something that is not considered a real fault, are not picked up. By recording the material, it is possible to re-try the same product without having to re-run it through the machine. Physically re-running material can often impart more faults and can cause material to be scrapped unnecessarily.

The end stage of the textile manufacture process, in terms of shipping rolls of textile from the factory door, tends to be dying and finishing (although this depends on the type of textile being manufactured). Eagle-eyed customers of the end product inspect rolls arriving at their goods inwards and then apply discounts to the price paid based on defect types, quantities and positions. It is important for the dyer/finisher to minimise faults in dispatched material and anticipate any rejection rates. Traditionally this has led to a very manpower intensive manual inspection system looking for not only manufacturing faults from weavers and knitters, but also dye faults, finishing faults and material specification. Finishing faults and manufacturing faults are covered by traditional defect detection methods. Colour and material specification require different techniques.

Colour is a very subjective effect to judge. A surface will appear as a different shade or even colour under different illumination, angle of view and to different observers. Even two nominally identical ‘white’ lights can lead to differing colour interpretations. Colour is measured using a spectrophotometer and many bench-top versions exist which give highly reliable colour measurements in lab conditions on small samples. The WebSPECTOR® can offer measurement of colour at three discrete sample positions across the width of the roll and along its entire length.

With the application of machine vision, a manufacturer can supply a better product with fewer inherent defects, a standard level of applied inspection and

information showing the location of those faults, which are included. The customer now has everything he needs to buy with confidence.

For further information please call Mark Shelton on 0116 275 3421 or email mark@sheltonmachines.co.uk

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