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AUTOMATED VISION INSPECTION SYSTEMS INCREASE CUSTOMER CONFIDENCE IN THE TEXTILE INDUSTRY

Textile manufacture is renowned for the variability of its product. Historically this is due, in part, to the variation inherent in the natural raw materials used. With more modern yarns some causes of variation are removed. However, the processes of spinning, dyeing, weaving, knitting and finishing can still cause many faults in the finished goods - from obvious holes through to variations in shade across a finished garment. If small faults created in one stage of a textile's life make it through to the next stage then the cost implications in terms of customer confidence, waste disposal costs and lost added value can be great.

The textile industry produces a huge and diverse range of products covering everything from the traditional woven or knitted fabrics for clothing through to fibreglass and technical textiles used in automobiles and body armour.

Traditionally inspection has been performed in two areas. The machine operators will keep an eye on the production process and make alterations as they see fit to keep production within acceptable bounds, but they are not inspecting all of the product all of the time. With production speeds sometimes exceeding 150metres per minute, they may only be aware of the gross defects.

Detailed inspection is then done off line and frequently at a significant time-lapse period from manufacture with the result that any manufacture-induced faults are introduced many times. The detailed inspection is performed at slower speeds and several inspectors are required to keep up with production rates. This introduces the problem of variation between inspectors in addition to variation in the standards applied by an individual inspector as concentration waxes and wanes.

The solution is an inspection system with 100% attention that can cope with full production speeds and apply consistent quality standards right at the point of manufacture. This real time quality feedback can be used to not only identify defects and prevent them getting through to a customer but also to provide information to machine operators to reduce the reoccurrence of faults.

Within the textile industry the range of products and production machines is very varied. Product size, width, colour, production speed, environment and textile construction complexity are all variables which mean that a standard off the shelf

system could not be designed. However, there are similarities across the industry, and indeed, with many other industries such as glass and lithographic plate manufacture, which have allowed Shelton Vision Systems to adopt a modular approach to provide a solution for several well-known manufactures.

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

1. 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.
2. Fault detection tasks involving unknown data are covered by the webSPECTOR® Standard system.
3. Tasks requiring increased functionality such as database 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.

Training an automated inspection system to find a fault depends very much, on what is being produced and for what market. An inconsistency that is a fault for one manufacturer may not be a fault for another. Indeed, the same inconsistency in the same textile produced by the same manufacturer may or may not be a fault depending on the customer to which it is going to be dispatched. Just as a human inspector can tailor his 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 code or with the webSPECTOR® *plus* it can be performed automatically using the automatic training function. Automatic training is facilitated by passing fabric through the system and allowing it to automatically set sensitivity levels relative to the material, it is training. 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 fabric type reference and can then be used for all subsequent occurrences of that fabric. The result is that each instance of that fabric type is inspected to the same standard reference.

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 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 fabrics through to colour variations and on to the geometric structure of fabrics used in technical applications such as car air bags.

Fabric defects such as holes, stains, slubs and knots tend to be created at the knitting and weaving stage. They can be as small as a few tenths of a millimetre running past the inspection system at up to 200 metres plus per minute. The contrast between a fault and the cloth may be relatively constant, as in white fibreglass, or may vary as in a textile mill producing cloth from black through to white.

Owens Corning Veil, a fibre glass sheet manufacture, have 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 manual inspection has to be done off line.

When inspected manually the fibreglass is batched and moved away from the production line for detailed inspection. The high output of this process (currently 175 meters per minute) means the rolls are inspected on a sample basis. This, combined with varying concentration levels of an individual inspector, leads 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, huge quantities of sub standard 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's use of an automated machine vision system has lead 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 lead to a significant cut down in waste as production alterations can be made in real time. 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.

The Shelton automated vision inspection systems, which can work at high speed and in hostile environments, are providing real time feedback about the visual state of a product, allowing processes to be adjusted or stopped and thus greatly reducing the quantity of poor quality production. The inspection data is typically linked in to a factory wide quality system to provide detailed analysis of process performance. For a company such as Owens Corning Veil, where the six sigma methodology is the Holy Grail this is an invaluable tool.

Subir Chandra, of Owens Corning, said “the webSPECTOR® 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 and improve the line conditions over time, and drive down waste even further.”

Owens Corning further utilises the data produced by the webSPECTOR® 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 PTFE laminate products.

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® system is expected to deal (several thousand individual products). To cope with this the Shelton WebSPECTOR® *Plus* system has an inbuilt self-learning utility. This enables diverse and rapidly developing or changing product ranges to be inspected to standards higher than human inspection, where they wouldn't otherwise be.

New products are introduced all the time. Due to 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.

The webSPECTOR® system employs several automation related technologies, to overcome this problem. The first is the webTrainer module which trains the system sensitivity settings on all products in an unsupervised fashion. It does this by assuming most of the material it sees is good product and then trains itself to expect that texture. During inspection, deviations from the normal appearance are then sent for further analysis by a classification module. 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, 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. It is more common that the inspection system sees genuine faults not picked up by inspectors. The webCorder is also useful in ensuring that false alarms are not picked up, where the system sees something that is not considered a real fault. 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 often imparts 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 lead to a very manpower intensive manual inspection system looking not only for 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 differing 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 measurement 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 manufacture 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 every thing he needs to buy with confidence.

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