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Dr. Schenk GmbH Industriemesstechnik

Faster setup, more reliable testing – New AI approaches for modern web inspection

A contribution by Jochen Sander, Product Manager at Dr. Schenk.

Technology transfer as a driver of innovation

Dr. Schenk GmbH Industriemesstechnik has been active in the field of optical inspection of all types of web material or flat products (e.g., glass) for more than 40 years. A significant part of its innovative strength comes from intensive research and development work and the ability to transfer technological advances from one field of application to other industries in a targeted manner.
One example of this technology transfer is the AI-based inspection of natural leather: around two years ago, Dr. Schenk succeeded in reliably inspecting cowhide automatically for the first time worldwide. For decades, this task was considered the “holy grail” of industrial image processing. Even human inspectors often need several months of training to reliably detect and distinguish defects. The reason for this is the enormous variability of natural defects, which often show only minimal contrast and are almost “hidden” in highly structured, equally natural backgrounds. (Figure 1)

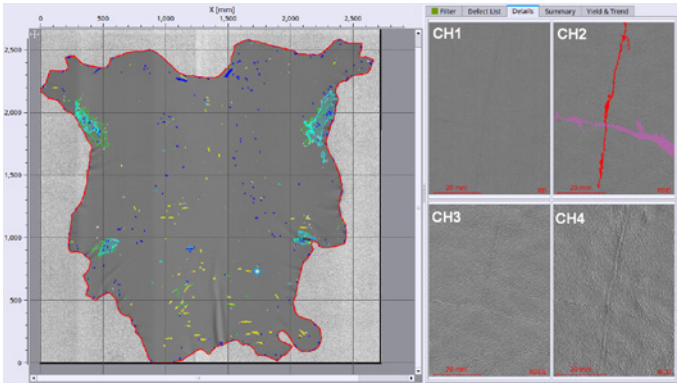

Fig.1: Only with AI and special lighting (e.g., channel CH4) can the flaws “hidden” in the natural leather structure be made visible.

The solution is based on the interaction of Schenk's multi-channel MIDA (Multi Image Defect Analysis) illumination, specialised AI, and image evaluation integrated directly into the camera. Today, numerous systems are in use worldwide. This technological basis has been transferred to processes in the converting and textile industries. This results in decisive advantages for industrial web inspection that cannot yet be achieved with classic standard AI products:

» Almost 100 percent detection and extremely reliable classification of defects
» Significantly reduced training times
» High inspection speeds of up to 3,000 m/min
» Reliable detection of even the smallest, low-contrast defects on highly structured surfaces

These aspects are explained below using the example of inspecting denim fabrics, which are significantly more challenging than the materials typically used in the converting industry.

Common challenges in textile and converting processes

Nowadays, fashion chains make high demands on the quality of denim fabrics, even though price pressure is considerable and cheaper materials are often used. Parallels can be drawn here with a wide range of converting applications. For the economic efficiency of production, it is therefore crucial to cover the entire production process of a plant with only one or two central inspection systems. The inspection systems must be adapted quickly and as automatically as possible to different types of fabric. At the same time, small weaving and coating defects, inspection speeds of approx. 100m/min, and web widths of up to 4 m place high demands on optical inspection.

Technology approach for secure AI-supported inline inspection

A) Reliable defect detection starts with the image
Universal, high-performance, and easy-to-use AI is something you find in science fiction movies or in marketing. In industrial reality, the nearly 100% detection and classification reliability achieved is based on several interlinked technological pillars.
The starting point is always a camera image that is as perfect as possible. Without meaningful and differentiated image data, even the most powerful AI is unable to make reliable decisions. In short: what is not contained in the image cannot be found.

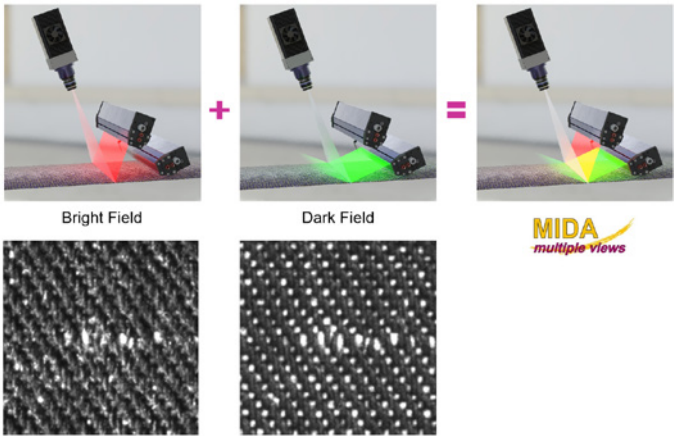

Fig.2: The different lighting angles reveal imperfections in different views.

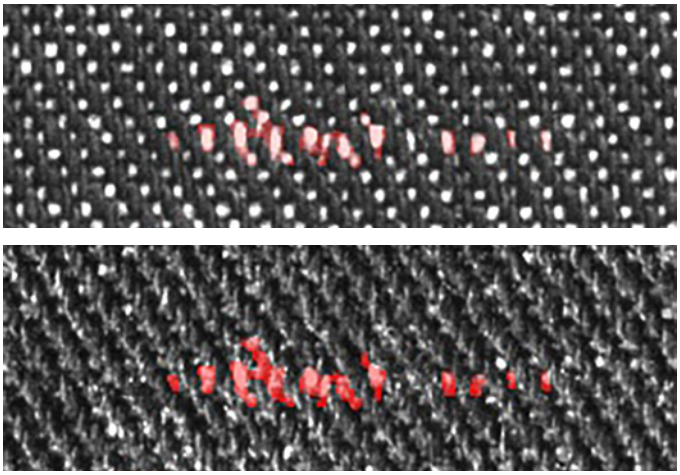

Fig.3 & 4: AI detection of thread thickening in jeans fabric in two different image channels

The MIDA technology developed by Dr. Schenk is particularly helpful in this area. Multiple light sources illuminate the fabric from different angles. This approach generates different "views" of the same defect, each emphasizing different characteristics (Figure 2). At the customer's site, for example, three light sources are switched at a frequency of up to 280,000 Hz to avoid mutual interference.

This multi-channel information enables clear classification of different types of defects: differences in material brightness – such as streaks or oil stains – can be reliably distinguished from spatial defects such as fraying or structural disturbances such as thread breaks and thickening (Figures 3 and 4). This differentiation forms the basis for stable, reproducible classification and is also used in the plastics, paper, and nonwoven fabric sectors.

B) Quick setup thanks to adaptive AI
A key advantage of the new AI technology is the drastically reduced training phase. No adjustments are necessary for fabrics with similar textures. Even for jeans fabrics that differ significantly, three to seven sample images are sufficient to achieve reliable detection – setting up a new recipe often takes only five to ten minutes. By comparison, classic rule-based systems typically require one to two hours of configuration, as well as additional fine-tuning during operation, and do not achieve the same level of performance.
The basis for this is AI whose learning logic has emerged from the demanding task of real leather inspection. In this context, Dr. Schenk's AI was designed to replicate human defect perception particularly quickly and accurately and to understand which natural variations are permissible and which must be evaluated as defects. This knowledge can be transferred surprisingly well to textile and converting-related materials.
This fast yet stable setup proves to be a decisive advantage for production environments where material changes occur frequently. Another advantage of this solution is its high degree of modularity: AI-based inspection can easily be retrofitted into existing systems. New generations of AI can be introduced without the need for time-consuming relabelling. Given the rapid pace of development in the field of AI, this is an advantage that should not be underestimated in terms of the system's future-proofing.
The performance is also evident in a direct comparison: Compared to the AI generation from two years ago, an improvement of approximately 87% in sensitivity and specificity was achieved. This significantly increases not only the speed of setup, but also the precision of quality assessment.

C) Real-time AI for fast web processes
At the customer's site, AI control was limited to speeds of up to 100m/min due to the web width of 4m. However, Dr. Schenk's technical capabilities are significantly greater: in applications in the paper industry, Dr. Schenk controls web widths of over 11 m at speeds of almost 3,000m/min with AI support. The AI system processes image data streams that are a million times larger than those used in high-definition televisions. This means that nothing stands in the way of real-time AI control in the textile and converting industries.
The key to this performance lies in the system architecture. Dr. Schenk develops both the camera technology and the image processing itself, shifting essential computing processes directly into the camera. The computing power of the FPGAs integrated in a single camera is comparable to that of a large 32-core server. This architecture allows the use of sophisticated AI algorithms and additional analysis methods without any loss of speed. At the same time, the number of detectable errors increases, while the systems work faster and more stable than conventional inspection solutions. For particularly high availability requirements, it is possible to transfer the evaluation completely to a virtual PC in the company's data centre. This has the advantage of eliminating the need for local PC hardware. The cameras themselves are designed for long-term stable use and come with a warranty of up to ten years.

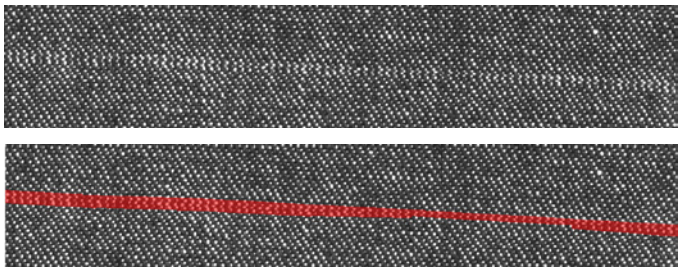

Fig.5: AI detection of a web defect

Benefits for production and quality assurance

The technologies described demonstrate that AI-based optical inspection in the converting and textile industries has now reached a level that goes far beyond traditional defect detection. This results in concrete economic advantages for users: high and stable detection rates, significantly reduced setup times when changing materials, and reliable inline inspection even at high speeds and large web widths. At the same time, operating costs, scrap, and dependence on manual quality assessment are reduced.
An additional efficiency factor lies in the integrated system architecture. Dr. Schenk GmbH Industriemesstechnik provides a uniform AI ecosystem in which recipes, AI models, and training data are managed centrally.
This is done both across locations and across the group. This means that recipes developed in one plant can be transferred directly to plants in sister factories without the need for relabelling or adaptation.
This also creates strategic added value: quality knowledge is digitally preserved, new lines or plants can be put into operation much more quickly, and quality standards can be standardised worldwide. Visual inspection is thus evolving from a pure testing tool to a central knowledge and control platform for modern production.

www.drschenk.com
Image source: Dr. Schenk GmbH