ZERO DEFECT MANUFACTURING

FROM RESEARCH TO PRODUCTION

PROFACTOR

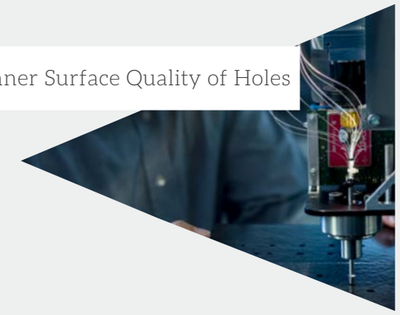
ZERO DEFECT MANUFACTURING

Optical quality control goes beyond good/bad-decisions.

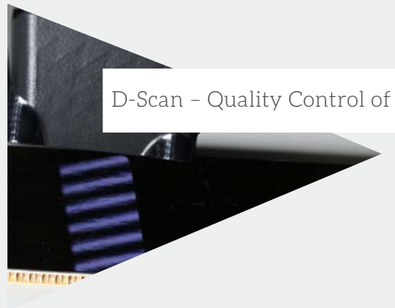
PROFACTOR develops control systems that learn from human decision making.

Machine learning for machine vision systems is of growing importance to deal with the variability of industrial production. Learning systems are particularly required in the field of surface inspection and quality control. The final goal is to proceed from the detection of defective parts to avoiding defects by closing the feedback loop to the production process.

F-Scan – Measurement of Fibre Orientation on Composite Parts



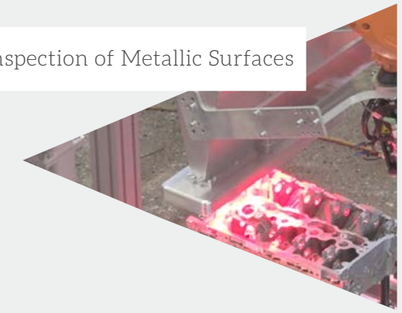
H-Scan - Inspection of Inner Surface Quality of Holes



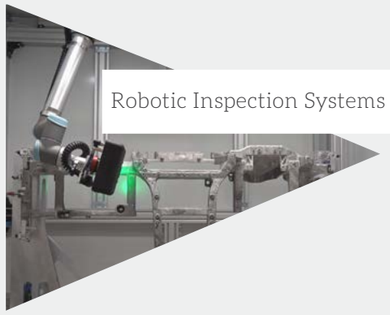
D-Scan – Quality Control of High-Gloss Surfaces

L-Scan – Inline Control for AFP Processes

Active Thermography for Crack Detection



TP-Scan - Inspection of Metallic Surfaces



Robotic Inspection Systems

F-SCAN – MEASUREMENT OF FIBRE ORIENTATION

Fibre analysis with directional illumination on composite parts

F-Scan is a sensor technology that allows the accurate measurement of fibre orientation on composite parts. The technology can be used for different types of materials (carbon, glass) and also during different stages of the production process (raw material, preform, clear-coated part). Aside from measuring the orientation it allows the detection of typical defects such as inclusions or distorted fabric.

New developed reflection model

Depending on the direction of incoming light, CFRP materials appear either black or shiny bright. These complex reflection properties of CFRP materials pose difficulties to quality inspection based on conventional image processing. Using an elaborate reflection model, the F-Scan sensor developed by PROFACTOR is especially designed for analysis of carbon- or glass fibre materials. By analysis of differently illuminated images, positions and orientations of fibres are captured by the sensor.

Your advantage

- Inline-inspection
- Compact and robust housing
- Flexible programming
- Fibre orientation analysis
- Feedback to simulation

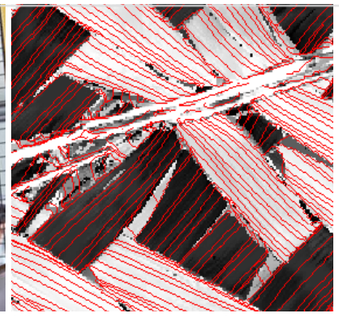
Application areas

- CFRP & GFRP fabrics, pre-forms, and parts
- NCF & woven materials
- Fabrics with and without sewing yarns

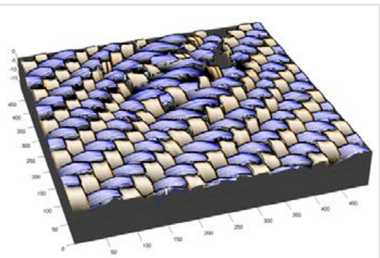
References

- Automotive
- Aerospace
- Lightweight construction
- Sports, racing, yachting

F-Scan



Fibre orientations as streamlines



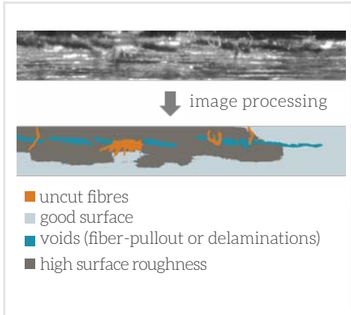
3D Reconstruction

Technical data:

- CMOS-Sensor
- Connections: Power, Ethernet, Trigger
- 288 high-power LEDs (programmable patterns)
- Evaluation with industrial PC
- Maximum speed (scan in motion): 1 m/s
- Size (approx.): 200 x 200 x 300 mm
- Field of view: 50x50 mm
- Resolution: 40-60 µm

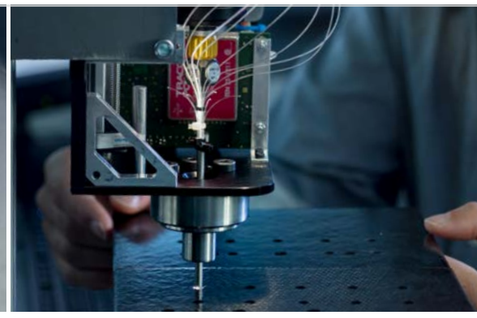
H-SCAN - INSPECTION OF HOLE QUALITY

Robust automatic inspection of the inner surface



H-Scan defect-segmentation

Metallic parts or composite parts



H-Scan

Manual control is cost-intensive

Boreholes often include functional surface, such as sealing surfaces, for which tight quality criteria apply. In addition, the presence of burrs and chips inside the holes is a problem as it might lead to malfunction of the parts after assembly. The inspection of such holes, especially when they have comparably small diameters, is time-consuming and difficult to automate. Similar problems apply to the manufacturing of e.g. motor components in the automotive industry as well as composite parts that are drilled for riveting in the aerospace industry. In both cases an assessment of hole quality is helpful for quality control in series production or for process development.

H-Scan inspects the inner walls of boreholes within seconds

H-Scan is an inspection system that inspects the inner walls of boreholes within seconds using an endoscope camera. From a series of images that is acquired using different illumination the robust detect of surface defects, burrs and chips is possible. Specific algorithms have also been implemented for the assessment of hole quality of carbon fiber composite parts.

For a borehole depth of one centimeter, a cycle time of only three to five seconds is achieved during the inspection process.

Application areas

- Automatic or manual inspection of holes
- For process development or series production
- Metallic parts
- For CFRP parts and carbon-metal composites

Your advantages

- Simple surface characterization inside holes
- Easier to handle than manual endoscopes
- Photometric stereo for full characterization
- Automatic documentation

References

- Aerospace
- Lightweight construction
- Automotive
- Sports, racing, yachting

Technical data;

- CMOS-Sensor, 1500x1500 pixels
- 8 high-power LEDs
- Max. hole depth: 40mm
- Min. hole diameter: 4.8mm
- Dimensions: 150mm x 120mm x 250mm (WxDxH)

D-SCAN – QUALITY CONTROL OF HIGH-GLOSS SURFACES

Objective measurements to match human perception of high-gloss surfaces

Subjective impression of the surface
Wood veneer surfaces play an important role as lightweight decorative parts for the aviation industry. These surfaces are high-gloss lacquered, the quality of which is critically assessed by OEMs during acceptance tests. Measuring instruments are used which supply characteristic values via the surface properties.

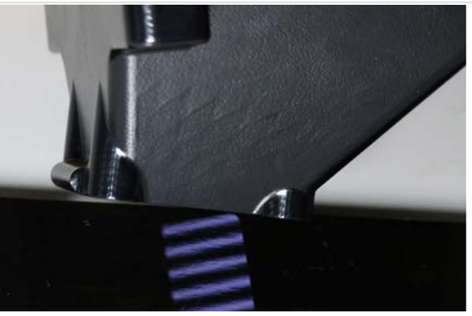
Even with characteristic values that correspond to the specified tolerances, the subjective impression of the surface is often not sufficiently good.

D-Scan matches human perception
Basic physical measurements cannot accurately capture human perception of such surfaces. D-Scan offers surface characterization that matches human perception of high-gloss surfaces.

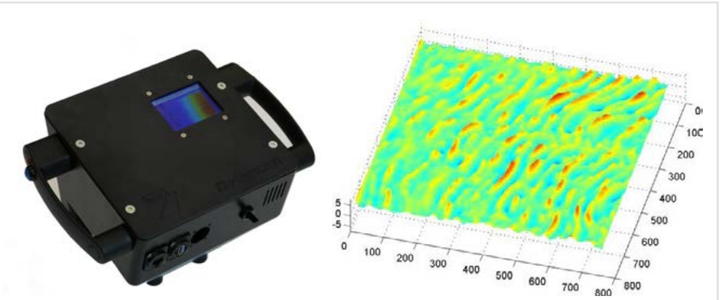
Your advantage
- Constant quality with objective measurements
- Surface characterisation through a single score
- Good match to human perception of surfaces
- Two-dimensional measurement instead of profiles
- Mobile sensor, wireless data transmission to PC

Application areas
- High-gloss interior parts
- Painted decorative components
- Chrome-plated parts

References
- Automotive
- Aerospace
- Lightweight construction
- Sports, racing, yachting



D-Scan

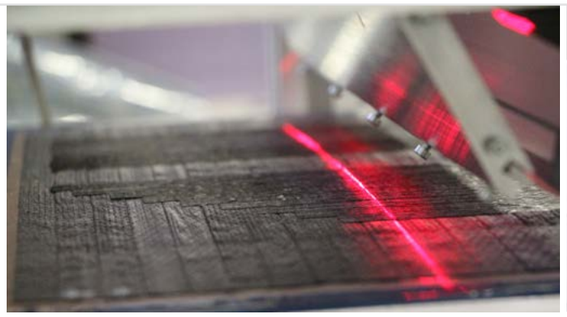


D-Scan offers surface characterization that matches human perception of high-gloss surfaces.

Technical data:
- CMOS-Sensor
- Integrated data processing
- Image size: 800x800 pixels
- Field of view: 50x50mm²
- Resolution: 60µm/Pixel
- Measurement time: 5s

L-SCAN – INLINE CONTROL FOR AFP PROCESSES

The efficient production of lightweight components is essential for the aircraft industry.



The L-Scan provides depth images for inspecting the edges of the individual carbon fibre tows.

Experience with composite fibre components
PROFACTOR has many years of experience with the visual inspection of fibre-reinforced composites. The L-Scan laser scanner was developed to meet the specific requirements of automatic fibre placement processes in the aircraft industry. It is able to control tow placement during the process. The sensor is equipped with optical components that cope with the complex reflective properties of carbon fibres. This was achieved by a specific optical attachment that scatters the laser line of the scanner.

Quality control in real time
The L-Scan provides depth images for inspecting the edges of the individual carbon fibre tows. Gaps between the tows are checked, typical defects such as overlapping, linting and twisting are detected robustly, false alarms are virtually eliminated. Errors are pointed out in real time - the L-Scan is integrated into the laying head. The position of the optically detected fault is calculated from the path of the laying head.

Your advantages
- In-line quality control
- Compact and robust construction
- Application-specific adaptation possible

Application areas
- Structural parts
- UD-materials
- Up to 32 tows

References
- Automotive
- Aerospace
- Lightweight construction
- Sports equipment

Technical data;
- Size: 320mm x 150mm x 140mm
- Field of view: 100x30mm
- Resolution (Pixel): 50µm
- Depth resolution: 100µm
- Realtime Linux System
- Evaluation time (typ.): 360 profiles/s (at 100x30mm size of view)

ACTIVE THERMOGRAPHY FOR CRACK DETECTION

Quality control beneath the surface of parts

Solution for automated and non-destructive testing
Conventional methods (like Magnetic Particle Inspection) for detecting near surface cracks and other defects beneath the surface of metal parts are pushed to their limits as they are error prone and very resource intensive. In addition to that, automation is often impossible.

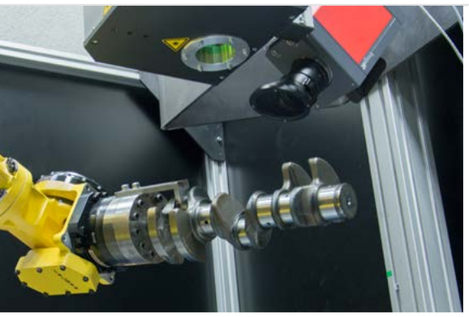
Heat-flow thermography, however, offers solutions for automated and non-destructive testing. Although some applications are still the subject of current research, PROFACTOR has managed to establish inspection systems in real production environments.

Measurements services
Aside from crack detection, the quality of joints and weldings, the presence of material inclusions and layer thickness can be tested. Also thermal diffusivity can be measured.

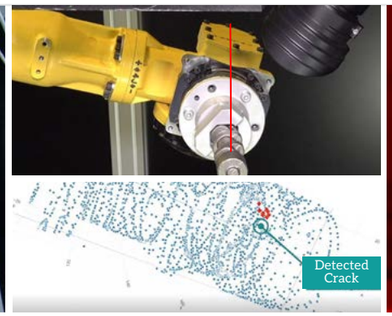
Your advantage
- 100% inspection
- Non-destructive and contact-less testing
- Fully automated inspection
- Documentation of results
- Faulty products are removed from the production line

Application areas
- Metal parts
- Forged parts
- Semi-finished products
- Composites

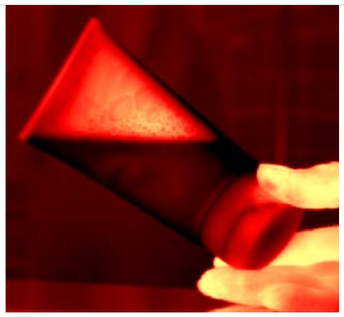
References
- Automotive
- Aerospace
- Steel industry



Heat-flow thermography



Seamless automatic inspection of complex parts

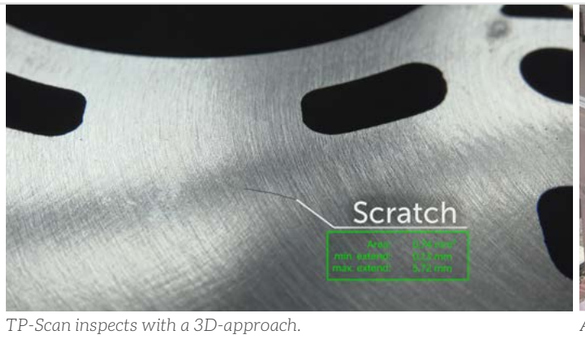


Thermal cameras monitor the heat propagation.

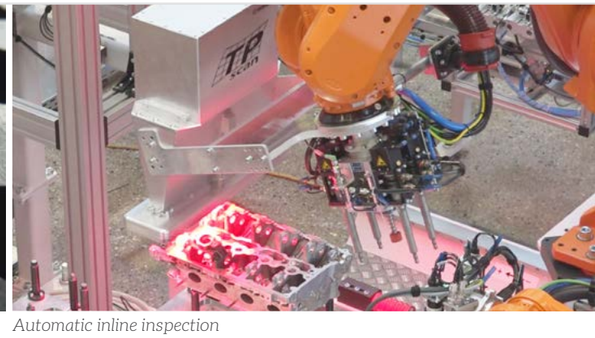
Technical data:
- Excitation: laser, flash, induction
- Lateral resolution: 30µm
- Temperature resolution: <10 mK
- Part weight: up to 30kg
- Automatic inspection path planning

TP-SCAN - INSPECTION OF METALLIC SURFACES

Surface inspection in the third dimension: intelligent system prevents pseudo-errors



TP-Scan inspects with a 3D-approach.



Automatic inline inspection

No compromises in quality control
For the automatic surface inspection of metallic components there is a major challenge: Unproblematic contamination, discoloration or detergent residues must be distinguished from relevant faults, such as cavities. The previous 2D systems cannot distinguish between these salient features. In practice, this means that a compromise had to be found between missing defective parts and unjustified waste for production.

The topography is measured
The TP-Scan sensor (topography scanner) from PROFACTOR solves this problem with a 3D approach: Measuring the surface topography enables a robust detection of scratches, cavities or other defects.

Illumination and reflection models
The system developed by PROFACTOR is based on multiple lighting angles and analysis of the resulting shadow casts.

Suitable for all types of metallic surfaces
The technology of the TP-Scan was developed to inspect the surfaces of crank-cases and cylinder heads. However, it can be used for the inspection of all types of machined metal surfaces.

The system can be installed inline and is already successfully implemented in industry. The single-pass scanning technology enables inspection of components with arbitrary length, including coils and rods.

Your advantages
- Detection and classification of scratches, cavities and other damage
- No pseudo-errors from contamination and discolorations by distinguishing between flat, recessed and raised flaws
- Low scrap despite strict quality standards
- High scanning speed
- Compact, dust-proof system

Application areas
- Metallic parts

References
- Automotive
- Steel industry

Technical data;
- Available resolution: 50µm, 100µm
- Scanning width: 400 mm
- Speed: up to 200mm/s
- Working distance: 25mm, 120 mm
- Module size: 600 x 585 x 220 mm
- Smallest detectable defect size: 150µm

QUALITY CONTROL SYSTEMS AND INSPECTION ROBOTS

Fully automated inspection of complex parts

For process development and automated inspection in series production entire parts need to be scanned. This requires that a sensor is moved over the whole surface of the part. For this purpose we develop fully automatic and semi-automatic inspection systems based on robots or other multi-axis handling devices.

These systems include features such as

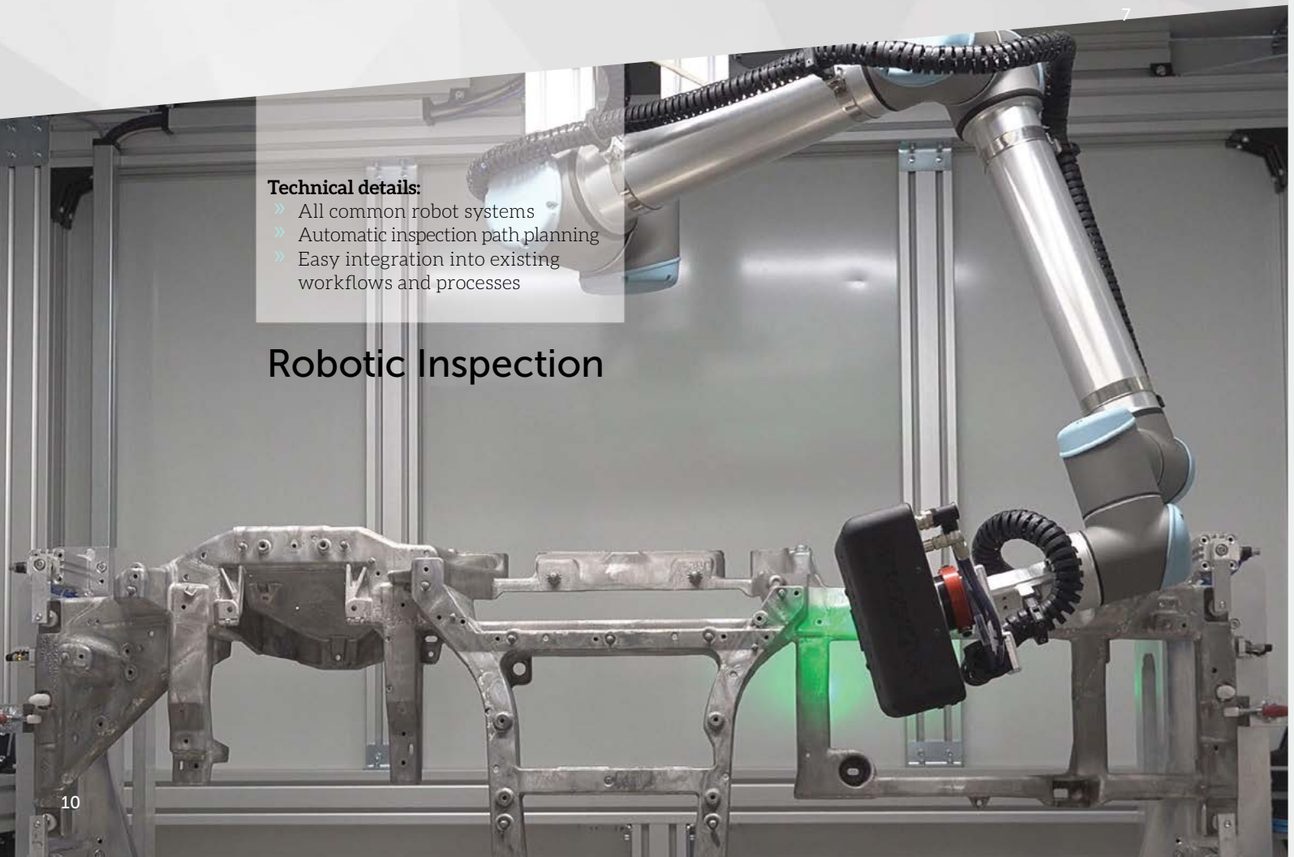
- Defect detection and classification
- Automatic path planning for robots to enable full surface scanning
- Defect mapping on CAD models in 3D for visualization
- Linking quality control results to follow-up processes
- Interfaces to database systems for documentation and part verification

Automatic motion planning
Wherever possible existing CAD models are used as a basis for the efficient setup of the inspection task, in particular for small lot-sizes and even single parts such as those made by additive manufacturing. The automatic setup includes the automatic coverage and motion planning to ensure that the part is fully inspected and that there are no collisions between sensor, robot, parts or other components of the workcell.

Algorithms are intelligent
Defect detection algorithms are based on state of the art methods including recent developments in machine learning. Algorithms have been developed for visual surface inspection using photometric stereo, 3D depth images and thermo-images for crack detection.

Analytical tool to continously improve
We also offer add-on functionalities for the offline analysis of quality control data to more quickly track down problems and continuously improve production processes, e.g. by identifying areas that are more frequently subject to damage and defects.

Applications include the surface inspection of die-cast parts in the automotive industry (major motor components, housings), the defect detection and fiber orientation measurement on composite parts in the aerospace industry (structural components) and crack detection in forged parts (for automotive and aerospace applications).
These systems are made to your specifications, retrofitting of existing robotic work-cells with sensor systems is also possible.



Technical details:

- All common robot systems
- Automatic inspection path planning
- Easy integration into existing workflows and processes

Robotic Inspection

IMPRESSUM
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