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A system solution with gigapixel multi-camera imaging

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End-of-line quality inspection with an edge AI platform

A system solution with gigapixel multi-camera imaging

Demand is growing for complete, compact vision solutions covering a wide range of requirements. In a system implemented by Cretec - a centralised, flexible, automated inspection cell - data from 17 cameras is managed, analysed simultaneously, placed in context and efficiently integrated into the company's communications network. This creates value on several levels and shortens the system's payback period.



Integrated with the conveyor, QBIC Wheels performs final quality inspection of wheels in a cycle time of less than 6.2 s.

Aluminium wheels must meet particularly demanding quality requirements. In the past, individual smart cameras were generally deployed locally and independently along the production line, each performing a limited set of vision tasks. Employees then carried out a manual end-of-line inspection. As people can perform such tasks with a detection rate of only up to 70%, defective wheels still reached the line. A new Cretec system has changed the process: at the end of the value chain, wheels from 14 to 26 inches are now assessed as pass or fail against numerous quality criteria,

with the results documented. Only completely defect-free products with documented quality assurance may reach the customer.

Multifunctional gripper module

A special gripper module lifts the wheel from the conveyor and moves it precisely into the inspection positions, including rotation. Its design allows compact, precise positioning. In this configuration, wheels can weigh up to 30 kg; the design can also be modified for larger objects. The wheel can be gripped at its upper or lower rim and rotated through 360° or more under precise control. It can also be aligned to a specific position, such as the valve hole. The gripper can additionally turn the object upside down, tilt it through 90°, or move it to any desired orientation. This allows the wheel to be positioned individually in any orientation in front of the cameras, using only a single Z-axis instead of a more complex six-axis robot solution. The complete process can therefore take less than 10 s.

Higher throughput

Several patented features in the QBIC cell enable highly reliable checks of numerous criteria using new acquisition methods and detection capabilities. Machine vision also identifies defects that can easily escape the human eye. Geometric features on both sides of the wheel are checked, and the coating, for example, is inspected for many quality

characteristics. A high-performance PC in the cell runs several neural networks and machine vision software based on the latest version of HALCON. Compressed images and all relevant inspection features are backed up on the PC, in the customer's IT system and on the customer's server. A large touchscreen provides a clear, detailed view of the quality assurance processes. The PC controls the entire cell. After extensive checks of the front and rear, the wheel is returned to the conveyor within the required inspection cycle time of less than 6.2 s; the achieved result is 5.88 s.

Custom-designed lighting

Many inspection features can only be detected reliably if the lighting provides the required capabilities across a broad range. Diffuse, highly uniform light from all directions supports reliable inspection of uneven metallic surfaces with curved and glossy areas, avoiding harsh shadows and interfering reflections. Dome lighting provides these conditions. No white-light product with such a large diameter was available on the international market. Alexander Trebing, Cretec's Managing Director, therefore designed the required dome light. Its 1,000 mm diameter provides suitable illumination for large components. Tyre fitters are already using it to read DOT codes. The light uses

16 segments rather than the four previously common on the market, with substantially improved detection capabilities. The LED rows are selected to suit the camera acquiring the image and are flashed sequentially during camera exposure. The lighting can be pulsed at up to 100 A. Shape-from-shading and photometric-stereo methods allow a 3D height model to be calculated from greyscale images captured under different lighting directions. Cretec extends these capabilities by combining 17 cameras and precise exposure control via flash controllers to create a multi-shading image. Acquisition takes 60 ms. Camera data is transferred to the computer over fibre-optic connections at rates of up to 100GigE. This gives vision systems a very broad range of capabilities for detecting fine defects in metal, cast, rubber and plastic parts.

Precise results with AI

The central top-view camera has a resolution of 65 MP, corresponding to a pixel resolution of 90 µm at the measurement plane. Measurements also use subpixel information, achieving accuracy below 0.09 mm and repeatability better than 0.09 mm. Sixteen angled-view cameras, each with 12 MP, are evenly distributed around the dome. An additional side-view line-scan camera scans the wheel's drop centre from the outside at 4k resolution. The dome's LED lighting is switched sequentially, allowing each camera to acquire several images from its viewing angle. The images are also combined using a multi-shading method. The following functions are implemented (RB = rule-based):

- Detect variable surface defects irrespective of wheel type or surface colour: AI

- Classify surface defects by defect type: AI
- Determine the exact defect size: RB
- Divide the wheel into inspection zones with weighted defect features: RB
- Set defect tolerances: RB
- Perform measurement tasks: RB
- Provide all GUI functions: RB

AI training follows an intuitive workflow through a clear graphical user interface, using all camera images. AI classification of defective regions takes place only at the end of the process and therefore focuses solely on the relevant areas.

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