Fraunhofer IPM

Inspect-360° HR

High-resolution dimensional accuracy and texture testing in free fall

Optical inline quality control of small parts

Inspect-360° HR detects dimensional accuracy and texture defects from a size of 30 µm on any small component by free-fall imaging. The system can be used for different types of components without setup process or component-specific handling.

Today, formed, stamped or injection-molded parts often have to be produced with tolerances of a few 100ths of a millimeter and without surface defects. Manufacturers face the challenge of documenting the quality of each individual part. The variety of small parts, which are usually processed in bulk, makes automated inspection with a single system virtually impossible. Inspect-360° HR from Fraunhofer IPM inspects small parts in free fall and thus enables automated inspection for a wide range of component variants.

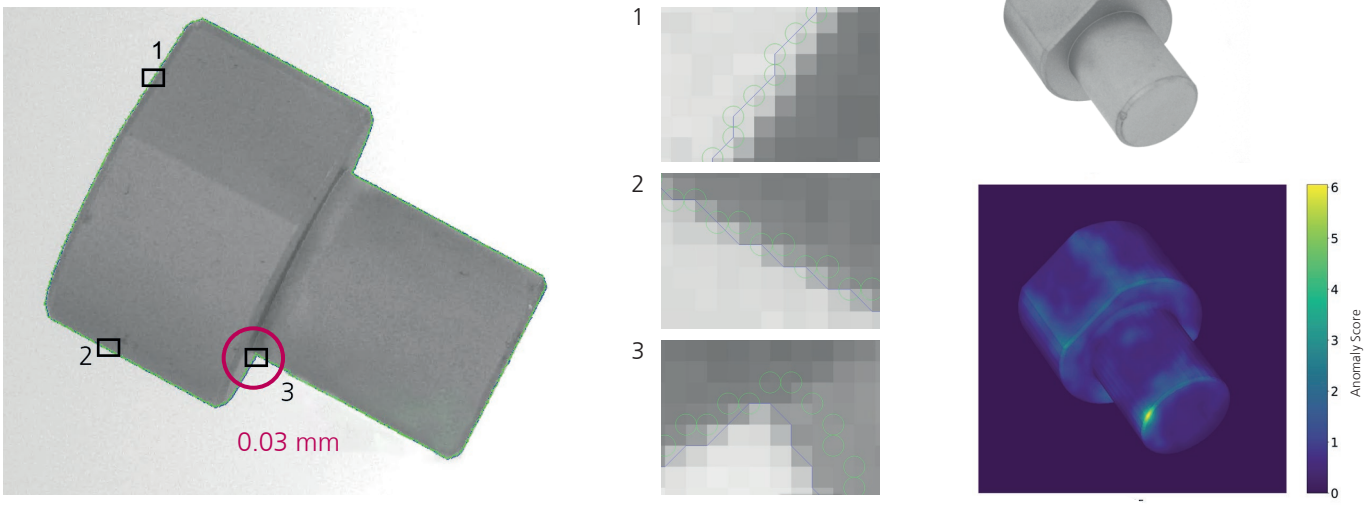
Automated inspection without additional handling

For quality control of small parts, random inspections are often state of the art. Component-specific automatic inspection machines inspect all parts quickly and accurately, but require complex component handling and cannot be used for other types of parts. Inspect-360° HR enables a largely type-independent inspection of such small parts without additional handling.

The parts to be inspected are transported individually into a hollow sphere via a conveyor belt. There, they are inspected simultaneously from all directions in free fall with the aid of 16 cameras. In the process, they are diffusely illuminated and appear free of shadows and reflections even if the surface is bare or coated with oil. The parts pass through the measuring volume every second in any orientation – no specific handling is necessary. Objects up to 60 mm in diameter can be inspected in the system.

Using real-time image processing, the 2D images acquired from different perspectives are mapped to the known CAD model and evaluated. For each 2D image, the deviation of the external contour to the CAD model of the respective view is calculated. Thus, dimensional accuracy errors can be detected immediately.

The texture of the parts is analyzed using AI-based anomaly detection. Anomalies on the surface can thus be quickly detected, which is already a great benefit for many applications. Only good parts are required for training the neural network, so there is no need for a time-consuming search for defective parts in advance. For example, scratches, stains and cracks are detected very quickly with the method. A downstream classification of the defects is possible. The evaluation takes place at one-second intervals, so that defective parts can be sorted out directly.



Inspect-360° HR quantifies dimensional accuracy errors as deviations in the outer contour from the CAD model to within a few hundredths of a millimeter.

An AI detects texture anomalies such as this impact point. The color shows the deviation from the norm.

High resolution despite free fall

To inspect small parts up to 30 mm in diameter with a tolerance of a few 1/100 mm in free fall, an almost microscopic optical resolution of 15 µm is required. For this reason, the inspection sphere of the Inspect-360° HR has particularly small dimensions; this keeps the component's fall speed, and thus the influence of motion blur, low. With Inspect-360° HR, the drop distance to the point of image acquisition is just 25 cm. To reduce the drop distance, the photoelectric sensor that triggers the cameras is placed in the center of the inspection sphere. The cameras are arranged in such a way that the light barrier itself does not appear in the image. The image taken at fall speed is "frozen" by means of a light flash of a few microseconds emitted by 48 high power LEDs.

Since the depth of focus is limited at this resolution, the component must always fall through the center of the sphere. For this purpose, a flap is mounted directly at the inlet above the inspection sphere, which centers the component and directs it into a vertical fall.

Micrometer precision in the production line

Inspect-360° HR is suitable for inspecting formed small parts such as plugs, screws and bolts as well as injection-molded plastic parts. Dimensional and texture defects as small as approximately 30 µm are detectable. A single system can be used to inspect different parts without having to adapt the hardware.

Small parts can be inspected inline every second, allowing direct intervention or feedback into the process.

Inspect-360° HR can also be used to monitor and significantly shorten the setup and warm-up phase of a process. This can increase production efficiency and reduce scrap.

Typical system properties

Size of object	min. 5 × 5 × 5 mm³ max. 60 × 60 × 60 mm³
Size of surface defect	min. 30 µm
Cycle time	1 Hz
System dimensions	1.2 x 0.8 x 0.8 m³ (h/w/d)
Number of cameras / inspection perspectives	16
Lighting	monochromatic, diffuse

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