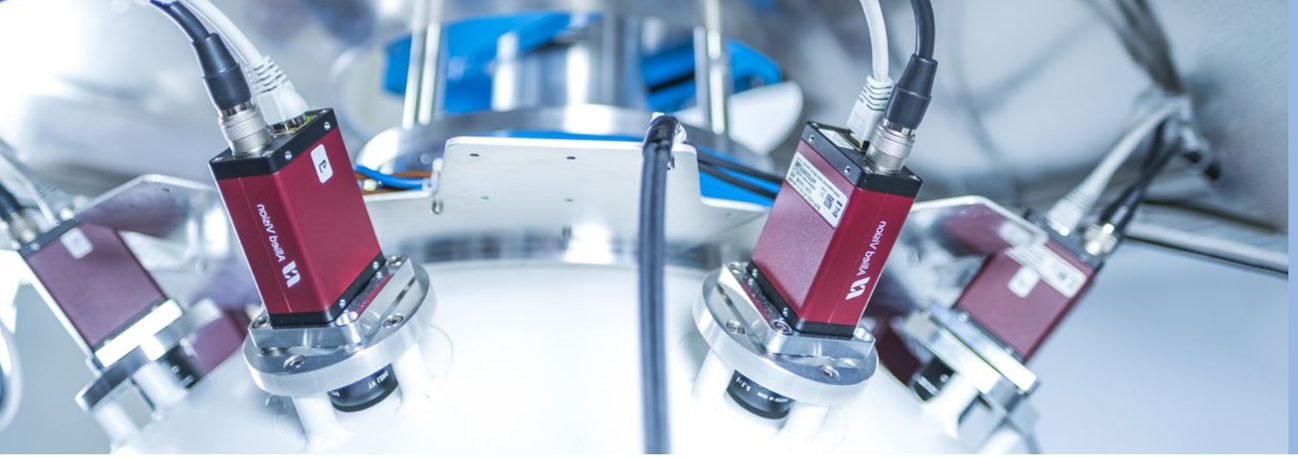


< To date, quality testing on mass-produced parts has been thwarted primarily by the need for component handling. Optical testing in free fall circumvents this problem.

GROUP **INLINE VISION SYSTEMS**

No need for handling: Component inspection in free fall

Large quantities, low prices – and high quality standards: Quality control on mass-produced parts presents many manufacturers of semi-finished products with problems that are almost impossible to solve. For automated optical inspection procedures, components must be oriented and positioned in a specific way. But it is disproportionately expensive to handle bulk goods in this manner. Inspect 360° from Fraunhofer IPM provides the answer. This optical system analyzes the geometry and surface condition of components in free fall – with no need for special handling.

Most products consist of a large number of individual components. In a single car alone, there can be up to a thousand different semi-finished metal or plastic items. These cast, blanked, drawn, and forged parts are produced at one-second intervals and transported on as bulk goods. Despite their low cost, they later perform important tasks in the finished product. Once they are installed, geometric deviations, defective surfaces, and contamination can have fatal consequences, for example where chassis and brake components, prosthetics, or drug dosing devices are concerned. As a result, strict statutory quality standards apply, particularly in industries where safety is an issue, such as the automotive, aviation, and medical technology sectors. It is therefore all the more astonishing that manual visual inspections and tactile gauging checks are still often the best methods available today for inspecting the quality of mass-produced parts.

Handling-free inspection

Optical measurement technology is capable of inspecting the dimensional accuracy and any surface defects of components with great reliability and precision. The problem with bulk goods, however, is the component handling that this requires. Parts tumble out of blanking and casting machines at one-second intervals. Even modern robotics cannot keep pace with this, and would anyway be disproportionately expensive.

The Inspect 360° system jointly developed by Fraunhofer IPM and the Fraunhofer Institute for Computer Graphics Research IGD elegantly sidesteps the problem of handling. Components are carried in succession directly from the conveyor belt to a hollow sphere where they undergo optical analysis in free fall. Each component passes through the inspection sphere, which is designed like an integrating sphere with a diffuse reflective interior, in just a fraction of a second. Several things happen during this time. 27 cameras fully map the homogeneously lit surface of the falling object in a single shot. Individual areas of the object are photographed from different angles, which significantly improves the robustness of the technique. Alongside 24 high-resolution inspection cameras, three lower-resolution tracking cameras with wide-angle lenses map the position of the component, which can fall into the free-fall inspection system in any orientation.

> **F-360°: CLEANLINESS TESTING IN FREE FALL** The sister system detects filmic contamination and particles on surfaces using fluorescence measurements. In order to perform these, the interior of the test space is illuminated by UV LEDs. This light activates the fluorescence of production residues such as oils, fats, and wet chemical cleaners. Any fluorescent light emanating from the surface is captured by six cameras. This results in an image showing all contamination across the entire object surface.

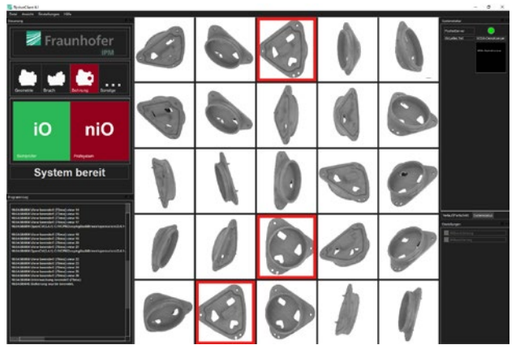
Real-time alignment with idealized 3D model

With this system, it is the geometry and surface condition of components that undergo analysis. The F-360° sister system additionally detects contamination and foreign particles. Any deviations in dimensional accuracy are determined by performing an alignment with a previously created, CAD-compliant 3D model of the component. Typical surface defects, such as cracks, holes, scratches, and spots, are detected by comparing the components with perfect parts. Geometric deviations, as well as cracks and pin-holes measuring just a few 100 µm, are detected in this process.

With the exception of optically inaccessible cavities and transparent components, the geometric complexity of components is of no consequence to Inspect 360°. The system can inspect components with diameters and edge lengths ranging from just a few millimeters up to diameters of 20 cm – test spaces are set up according to the specific requirements. Specially positioned, high-power LEDs ensure adequate lighting inside the hollow sphere. Apart from the two small openings for entry and exit of the components, the inspection system is fully encapsulated to ensure that any background or ambient light is completely blocked out.

“Bits not robots”

Inspecting components in free fall at the rate of production demands a great deal not only of the optics and system design, but also of the data processing technology. Specially developed AI-based algorithms determine the component type and the orientation of each test specimen directly after recording. The individual images are then matched to the corresponding view of the CAD model. In this way, the texture of the entire surface can be analyzed by real-time image processing. Defined areas of the model can be masked or examined for defects in more detail if desired. It is even possible to differentiate by quality class on the basis of previously defined deviations from normal. Quality-compliant parts are classified as such as they exit the test sphere, while faulty specimens are rejected.



Inspect 360° user interface: Image perspectives where defects have been detected are marked. By comparing the results of the visual inspection and the inspection system, inspection criteria and threshold values can be subsequently adjusted.

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