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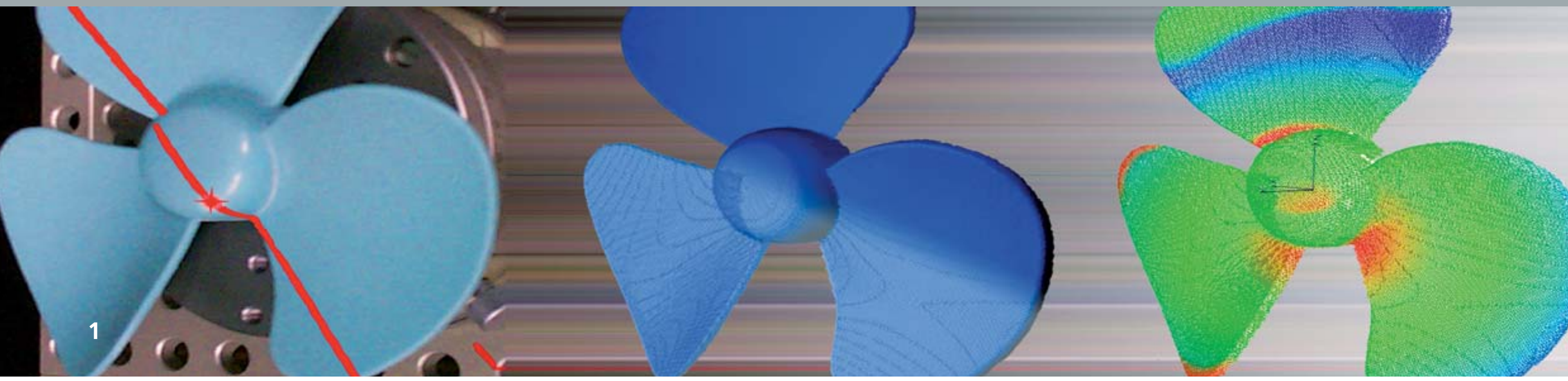

1 *Quality inspection by optical measuring systems. Photo: Fraunhofer IFF*

IN-LINE QUALITY INSPECTION WITH OPTOINSPECT 3D

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The Measurement Technology OptoInspect 3D

Optical 3D measuring systems are increasingly replacing classic tactile measuring systems. While new fields of application are being developed, few applications have been implemented.

OptoInspect 3D is a modular technology that produces automatic 3D measuring systems that inspect quality in industrial manufacturing. The focus is concentrated on integrating measuring and testing systems directly in manufacturing processes or machinery in order to produce high-quality products and make manufacturing processes efficient. OptoInspect 3D technology incorporates methods and tools that design, size and simulate laser light section sensors based on the principle of triangulation. This also includes the calibration and spatial orientation of systems configured from multiple sensors and sensor motion components for specific applications. Functions and methods that rapidly and automatically capture measured data, evaluate data and identify geometric features are another important component. A measuring system that inspects the geometric quality of vehicle wheels ideally presents the OptoInspect 3D technology and highlights its potentials.

Model Application: Wheel Inspection

The objective is to automatically inspect the geometric quality of vehicle wheels during manufacturing. To do so, position, shape and orientation tolerances have to be determined for the wheels' bead seats, center bores, bolt holes and mounting flanges.

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Working Principle

Optical inspection of geometry basically entails the following steps:

- 3D digitization of the object geometry
- Data preprocessing (filtering, purging, etc.)
- Segmenting and approximation of standard geometric elements
- Specification of a reference coordinate system on the object
- Ascertainment of geometric parameters for position, orientation and shape

3D Digitization

The object geometry is digitized optically and without contact. The laser sensors employed work on the basis of the principle of triangulation (laser light sectioning and point triangulation). The sensors are configured as a cluster and take measurements in a common coordinate system. A motion system consisting of translatory and rotatory axes of motion guides the sensor cluster over an object's surface, thus scanning it. The sensors are positioned beforehand to adjust their effective range for the type of component. The geometric specification of the sensor configuration, which is predefined one time by spatial orientation and calibration, the positions of the axes and the measured data from the sensors are used to compute a 3D point cloud in the global coordinate system. Selected regions of a wheel (bead seat, center bore, bolt holes and mounting flange) are digitized.

Data Preprocessing

In a first step, the data are preprocessed for evaluation. This involves eliminating errors caused, for instance, by reflections, reducing the quantity of data by thinning it and eliminating interfering geometries such as those from holding and clamping devices.

Data Evaluation

Measurement data must be converted into an object coordinate system to ascertain geometric parameters based on objects, i.e. parameters based on the wheel's coordinate system. In keeping with the specifications of the component reference system, the shaped elements, e.g. edges, holes and flat joint faces on the component, are used to do so. Standard geometries, such as planes, cylinders, cones and spheres, are fit into these shaped elements by numeric approximation. The position and orientation of the object coordinate system are ascertained from the parameters of the standard geometries.

The object coordinate system for a digitized wheel is specified on the basis of the wheel's virtual axis of rotation (center bore and mounting flange). When the measured data is on hand in the object coordinate system, the desired geometry parameters can be calculated with state variables or directly. Each of the relevant object domains (possibly individual light sections) of the data is used in turn to fit standard geometries.

The following wheel parameters can thus be ascertained:

Bead seat and center bore:

- bead seat diameter, circumference and eccentricity
- radial and axial runout and bead seat harmonic
- center bore diameter

Mounting holes and mounting flange:

- hole angle and radius
- position tolerances
- pitch diameter
- evenness of the mounting flange

The measurements are compared with the target data and the components are then classified as good or bad.

Wheel inspection is a representative example of a typical application of OptoInspect 3D technology for automatic in-line geometric quality inspection.
A multitude of already implemented systems solutions attest to the technology's suitability for industry.

2 *The insides of the in-line wheel inspection system. Photo: Bernd Liebl*

3 *The complete wheel inspection system. Photo: Bernd Liebl*