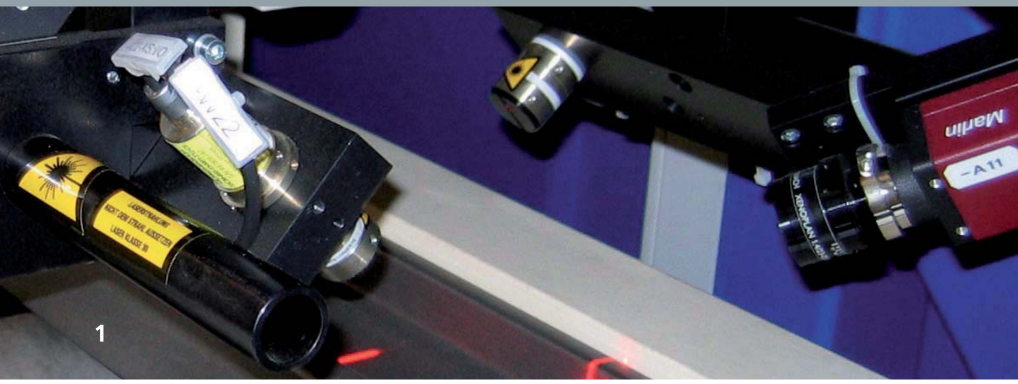
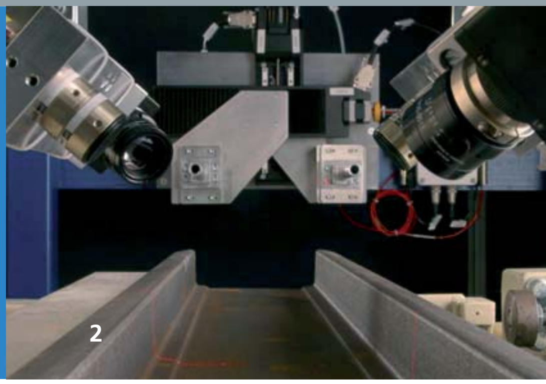
Fraunhofer

IFF

FRAUNHOFER INSTITUTE FOR FACTORY OPERATION AND AUTOMATION IFF





1, 2 *Sensor unit for straightness inspection. Photos: Fraunhofer IFF*

STRAIGHTNESS INSPECTION OF PROFILED MATERIALS

Fraunhofer Institute for Factory Operation and Automation IFF

Prof. Michael Schenk

Sandtorstrasse 22
39106 Magdeburg, Germany

Contact
Measurement and Testing Technology Business Unit

Dr. Dirk Berndt
Tel. +49 391 4090-224
dirk.berndt@iff.fraunhofer.de

Ralf Warnemünde
Tel. +49 391 4090-225
ralf.warnemuende@iff.fraunhofer.de

www.iff.fraunhofer.de

OPTOINSPECT 3D Measuring Device

Initial Situation and Motivation

Profiled materials, such as U, I, square or round profiled bars are used as base material to manufacture many products. These semi-finished products are normally drawn and rolled or extruded. Different applications have increased requirements for the straightness of base materials, which is the prerequisite for the end product's functionality.

OptoInspect 3D technology inspects the quality of a product's geometry directly in the manufacturing process. Optical contactless measurement systems based on this and adapted to specific tasks inspect the straightness of profiled bar stock directly in the manufacturing line. Automatic measurement and data evaluation facilitate the fastest delivery of inspection results possible and thus immediate process feedback.

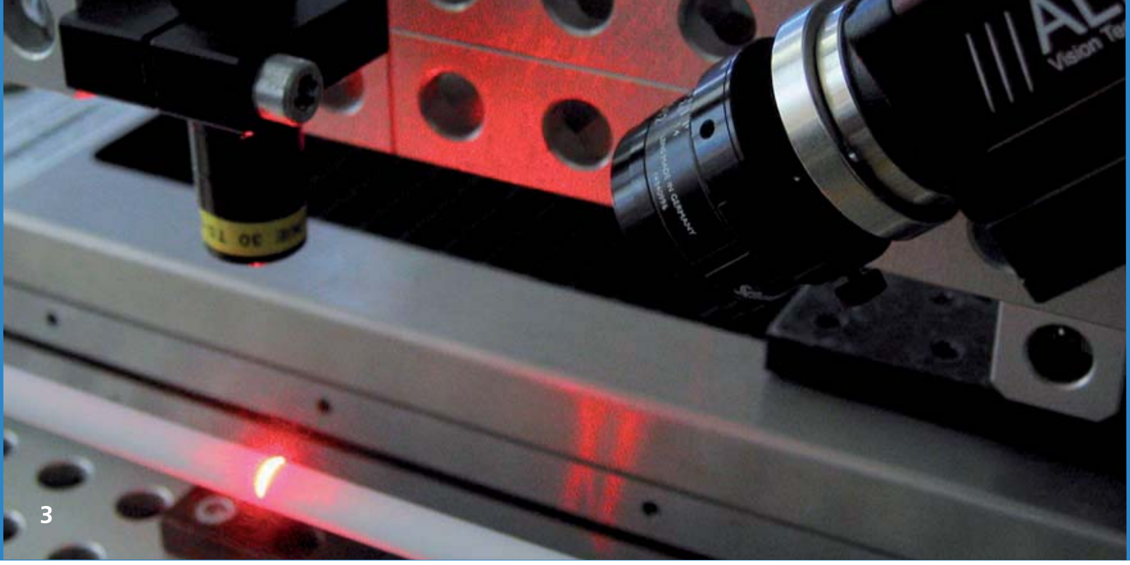
The Measurement Technology

Profiled materials are inspected in two steps. First, relevant regions of the profile surface are digitized three-dimensionally. In a second step, the data is evaluated, the geometric parameters are determined and a classification of good or bad is made.

The Measuring Principle

Laser light-sectioning is employed to digitize the surface of a structural element. Camera-laser arrays for light-sectioning sensors which scan the surface of a structural element line by line are configured as a function of the shape of the profile cross section. The data for one profile cross section apiece is captured with each measurement.

mpt_03_10_03_eng



Scanning Motion
Scanning the entire surface of a structural element requires relative motion between the test specimen and the light-sectioning sensor unit. The sensor unit moves along the profile's longitudinal axis. Trigger signals generated from the motion unit's position information control the acquisition of measured data and generate an equidistant sequence of profile cross sections along the structural element. The requisite maximum sampling rate is determined on the basis of an analysis of the potential straightness tolerance (Nyquist condition).

Precise linear motion is important for guiding the sensor unit along the profile. Otherwise, deviations from exact linear motion directly enter the results of digitization as errors. High-precision guides, e.g. air cushioned designs, and hard stone guide supports satisfy these requirements but are quite intricate.

An alternative solution dispenses with very high-precision linear guides and supports and utilizes linear axes with standard accuracies instead. An additional measuring system employs a position measuring system consisting of point lasers and two-dimensional position sensitive diode arrays in the form of PSD (position sensitive device) elements to detect and compensate deviations from an ideal linear trajectory. The PSDs are mounted on the rails of the linear axis and the lasers are mounted stationary on the machine frame. The change of the projected laser point's position delivers a measure for the deviation from linear motion. Thus, errors of typical linear unit such as radial and lateral run out, roll, pitch and yaw, are detected and compensated as a function of the position measuring system's configuration.

Measured Data Evaluation
Available as camera images, the sequence of profile sections along the profile axis generated by scanning a structural element constitutes the basis of measured data evaluation. In a first step, 3-D data is computed once the evaluated measured data has been preprocessed. The position of each laser line in the camera image is determined and parameters from the calibration of light-sectioning sensors are used to compute 3-D data for every profile section. A sequence of precise cross sections along the profile is produced by projecting the data onto a plane perpendicular to the profile axis. Subsequently, a feature point with a fixed reference to the profile axis is computed for every cross section. Mathematical approximation fits reference geometric elements (straight lines, circle segments, curves) in proper areas of the profile cross sections and, from this, one feature point is determined for every profile cross section. This produces a sequence of feature points that represent the profile in space and thus its straightness like string of pearls.

Determination of Straightnes
Depending on the shape of the profile, the chain of feature points is analyzed either symmetrically or axisymmetrically. The chain is examined in different projection planes, e.g. in the horizontal and vertical planes. For the different planes, mean, inner or outer reference straight lines are fit into the straightness profile according to defined rules compliant with the standard DIN ISO/TS 12780-1, Geometrical product specifications (GPS) – Straightness. This serves as the basis for determining straightness parameters.

Advantages and Benefits

OptoInspect 3D measuring technology automatically inspects the straightness of profiled materials directly in manufacturing. The sensor unit's flexible configurability permits customized measurement uncertainties and a wide diversity of different profile forms. The technology is suitable for all materials that are opaque and do not have any reflective surfaces. A multitude of already implemented system solutions has demonstrated the technology's suitability for industry.

For more information on this topic, visit www.mpt.iff.fraunhofer.de.

3 *Lab setup for straightness inspection. Photo: Fraunhofer IFF*