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Topographic Scanning with the New Chromatic Focus Line Sensor

With High Speed *and* Accuracy

Multidimensional distance sensors enable high point densities and measuring speeds. Often, however, this comes at a cost of increased measurement uncertainty. The new CFL Chromatic Focus Line Sensor is the solution.

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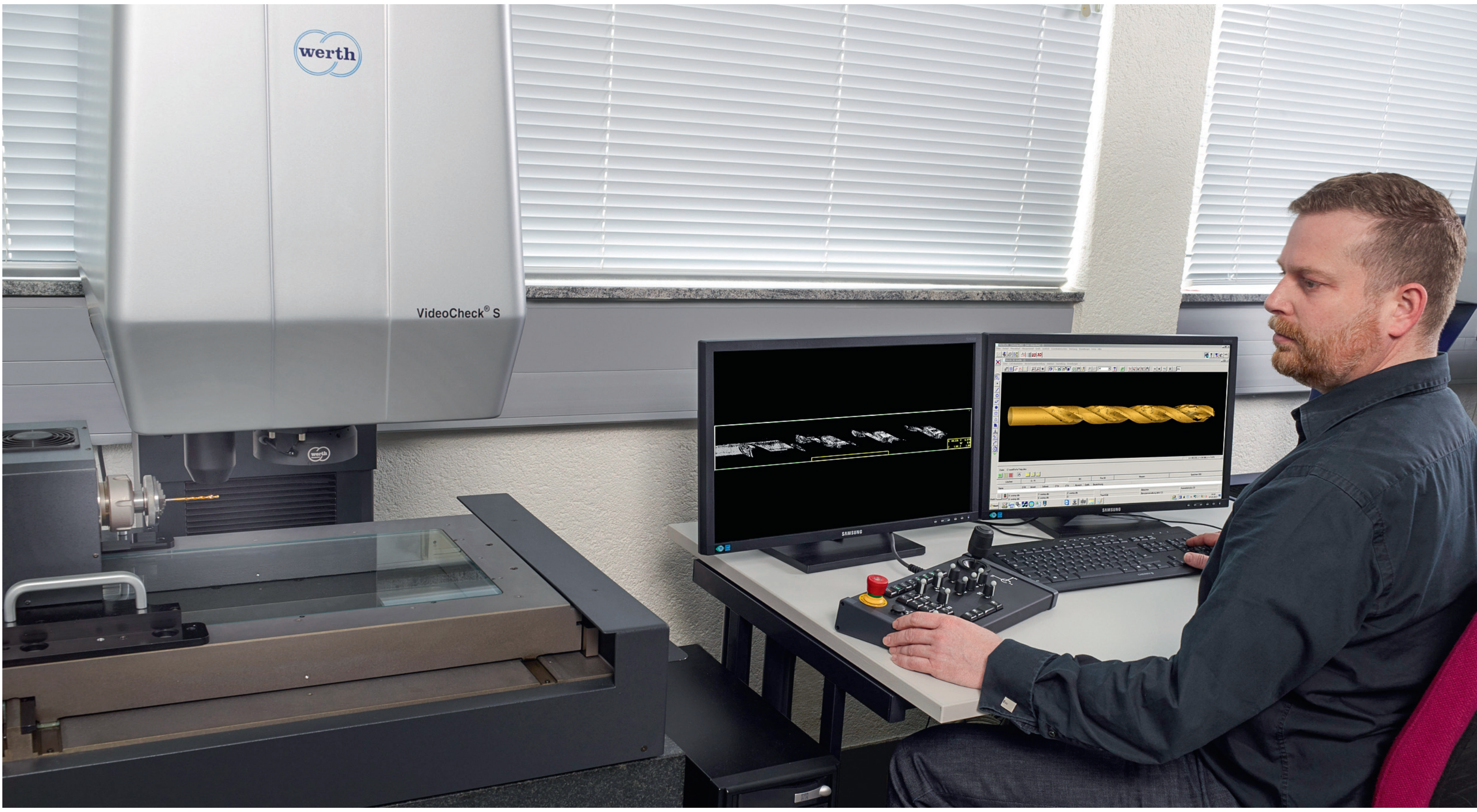
Using multidimensional distance sensors, it is possible to capture the entire surface geometry or a partial region of the workpiece in a single measurement. Conventional sensors, depending on their measurement principle, provide either high point density or high measuring speed. When such sensors are used in coordinate measuring machines, large areas can be captured with high point density by merging several measurement point clouds. Alternatively, regions of interest can be measured in workpiece coordinates and linked for analysis.

Werth multisensor coordinate measuring machines are equipped with various distance sensors for a wide range of measurement tasks. Depending on the captured measuring range, they can be classified as area sensors and line sensors. Examples of area sensors are focus variation methods or confocal sensors. The Werth 3D-Patch applies focus variation and analysis of the contrast between the individual image points to capture the surface topography with high accuracy and point density. The sensor uses the hardware of the image processing sensor, so the entire measuring range can be used for multisensor measurements without a loss of measuring range due to sensor offsets.

For combined measurements no sensor change is needed, avoiding additional measurement deviations. Due to the time required for capturing the image at different heights above the workpiece during focus variation, this method has a relatively low measuring speed. An additional prerequisite for its use is visible contrast from surface structures on the workpiece or from projected patterns. Measurements on polished or reflective surfaces are therefore very limited or impossible.

An alternative area sensor is the NFP Nano Focus Probe. This confocal sensor also captures a stack of images as

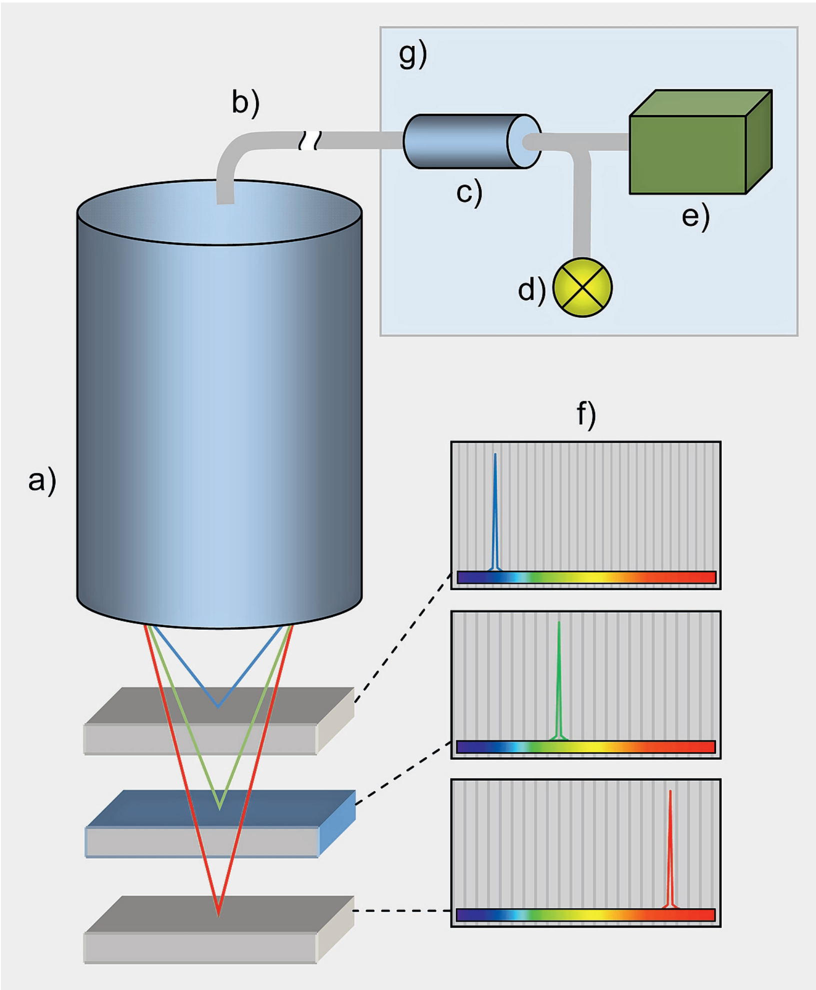


Werth multisensor coordinate measuring machines are equipped with various distance sensors for a wide range of measurement tasks. They can be classified as area sensors and line sensors depending on the measuring range. Image: Werth

it moves perpendicular to the workpiece surface. Instead of contrast, the image brightness is evaluated for every point. This makes the sensor independent of contrast at the workpiece surface, so that it is possible to measure even reflective surfaces. With interchangeable lenses, very low measurement deviations can be achieved, so that the sensor is suitable for determining surface roughness as well. Disadvantages include the small field of view and the short working distance for lenses with high magnification.
One example of a rapid line sensor is the LLP Laser Line Probe for fast digitalization of large areas in the lower accuracy range. The large working distance makes it easy to use. Even with a large measuring range of 15 mm in the X direction and 25 mm in the Z direction, the sensor achieves a high measuring speed.
While the flexibility of conventional distance sensors is limited, the new CFL Chromatic Focus Line Sensor allows workpieces to be completely captured in 3D with both high accuracy and high speed. The line sensor measures about one million measurement points in three seconds, at a line frequency of 2 kHz. The chromatic focus principle makes it largely independent of the workpiece surface properties. The CFL measures surface topographies at a high point density and is easy to operate from WinWerth software. With a relatively large working distance, typically 36 mm, even larger workpiece topographies can be captured.

Chromatic Focus Sensors for Diffusely Reflective, Polished, and Transparent Workpiece Surfaces

In a chromatic focus sensor, white light is projected onto the workpiece surface through a lens. The chromatic aberration of this special lens is maximized so that light of different wavelengths has substantially different focal planes. Reflection at the workpiece surface causes an intensity maximum for the wavelength whose focal plane is located there.
The reflected light is evaluated in a spectrometer and the wavelength with the maximum return intensity is used to determine the distance between the sensor and the workpiece surface. Direct reflection is neither necessary nor disruptive, and lack of contrast is also unproblematic. This means that diffusely reflective, polished, and transparent workpieces can all be measured using chromatic focus sensors such as the CFP Chromatic Focus Point Sensor.
It is also possible to use this measurement principle for a line sensor. The Chromatic Focus Line Sensor projects a



The chromatic distance sensor works like this: The probe head (a) is connected to the analysis unit (g) by a long optical fiber (b). The broad-band white light source (d) and the spectrometer (e) are connected by a fiber coupler (c) here. The spectra (f) indicate the distance from the object to the probe head.

Graphic: Werth

row of 192 individual points onto the workpiece surface. Rapid and easy capture of large areas with inclination angles up to about 45° is thus possible via scanning. The measurement uncertainty and range can be adapted to a particular application using different lenses. For a large axial measuring range, it is not necessary to track the workpiece geometry with a controlled motion, so very high measuring speed can be achieved when scanning. It is possible to scan workpieces with large variations in height along a pre-defined 3D path.

Flexible Applications for Different Measurement Tasks

The large measuring range and high measuring speed of the CFL make it possible to quickly and completely digitalize even large workpieces. The previously unachievable accuracy at this measuring speed also allows measurement of precision components and micro-features – for example, polished or transparent workpieces, such as die stamps and carbide or diamond tools, but also diffusely reflective plastic components. Even surface roughness can be measured with the CFL. The high point density allows topography of a wide variety of surfaces to be captured. This is ideal for precision mechanical workpieces like watch plates.

Inline Measurement of LED Array Coplanarity Using the CFL on a Coordinate Measuring Machine

One application example for the Chromatic Focus Line Sensor is the inline measurement of the coplanarity of LED arrays. A coordinate measuring machine with a CFL is integrated in the manufacturing line with a handling system. The measurement result is the entire shape of the workpiece surface in the form of a point cloud, which can be used to determine flatness or roughness and to measure geometric elements. A nominal-to-actual comparison with color-coded deviation plots is also possible.
In addition to the wavelength of the reflected light, its intensity is also analyzed and a raster image of the workpiece surface is produced. This is displayed in the WinWerth application as a camera image of the image processing sensor. Subsequent analysis with image processing software allows measurement “in the image” of geometric features or definition of the workpiece coordinate system. The positions for measurements with a variety of other sensors are determined on this basis, without requiring a sensor change. Features that cannot be captured optically, such as undercuts, can also be

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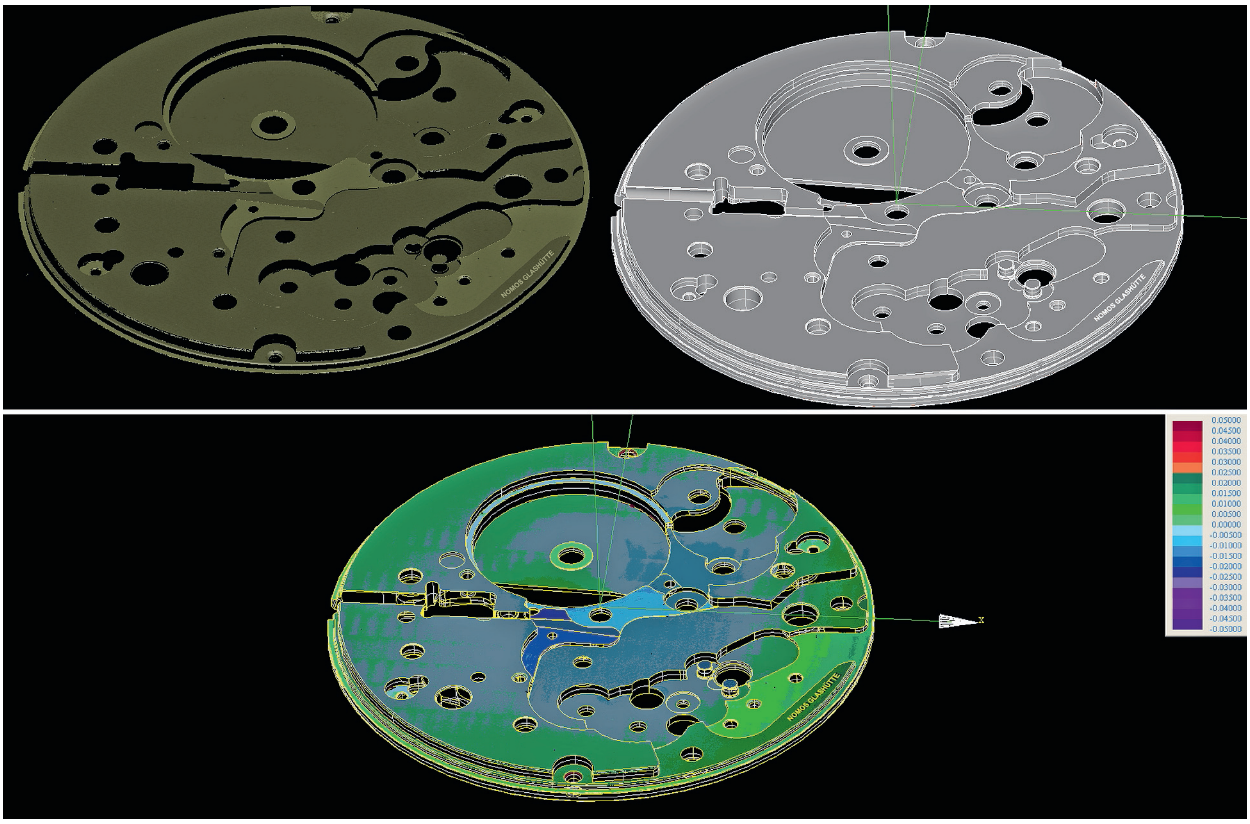
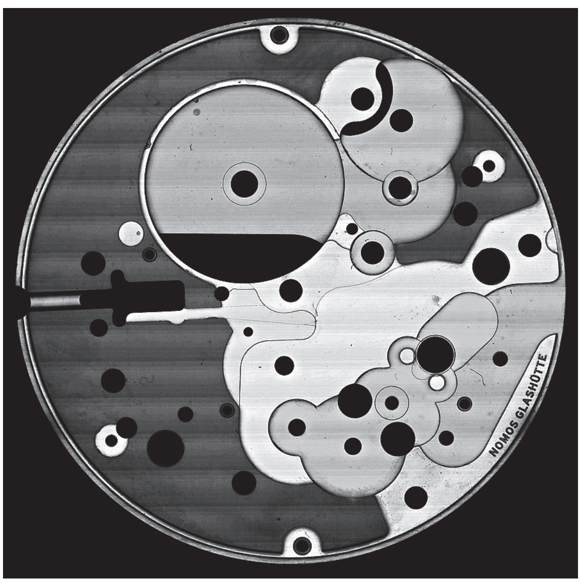


Point clouds of a watch plate measured by the CFL Chromatic Focus Line Sensor (top, with CAD model) and color-coded nominal-to-actual comparison (bottom). Image: Nomos/Werth

captured with conventional probe systems or the patented Werth Fiber Probe (WFP). If a partial region of a measured point cloud is to be analyzed, it is selected from the raster image using the window function of the image processing sensor.

With the Chromatic Focus Line Sensor, there is no need for compromise between accuracy and measuring speed. The flexibility of the CFL is another advantage. Due to its measurement principle, it is possible to use the sensor on dispersive as well as polished and transparent surfaces. This means that different measurement tasks can be addressed with the same sensor. The raster image allows rapid alignment and position determination, so large areas can be captured at a high measuring speed and the surface topography can be determined with high point density. ■



The Chromatic Focus Line Sensor also provides a raster image of the workpiece for measurements and position determinations. Image: Nomos/Werth

Web Reference

To learn more *about the Chromatic Focus Line Sensor, use the QR code or link below and watch the video.*

www.werth.de/cfl