Why to Use Multisensor Technology?

Complete Measurements on Multisensor Coordinate Measuring Machines

PRACTICAL TIP Sensors used in coordinate metrology are based on various physical principles. Several different sensors are often needed to measure areas of the same workpiece surface that have different properties. With a multisensor coordinate measuring machine, such measurements can be performed without changing machines, and all of the measurement results are provided in the same coordinate system.

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AUTOMATION of coordinate measuring technology started in early 1970s with tactile measurements. In 1977, the Werth Tastauge (Probing Eye) marked the start of development for automated optical coordinate measuring machines. The Werth Inspector of 1987 combined an image processing sensor with a laser distance sensor, resulting in a 3D CNC multisensor coordinate measuring machine. Additional sensors were developed over the following years and integrated into coordinate measuring machines to solve various measurement tasks.

Sensor Principles

Lateral optical sensors have a measurement range in the plane perpendicular to the optical axis. Image processing sensors in predominant use enable precise edge measurements with transmitted or incident light on profiles or 3D plastic components, for example.

Various measurement principles are used in axial optical sensors that are well suited for several different applications. There is a large selection of point sensors available. Focus variation sensors use the same hardware as the image processing sensor, thus eliminating a sensor change, but have only average measuring speed and require sufficient contrast on the workpiece surface.

Laser distance sensors using the Foucault principle are especially good for rapid scanning. The integration of the patented Werth Laser Probe (WLP) in the Werth Zoom beam path also eliminates the offset between the sensor and the image processing camera. Laser distance sensors are relatively dependent on the reflective properties of the workpiece surface. Chromatic focus sensors, however, are largely independent of the surface and have very low measurement uncertainty. Even reflective surfaces at large inclination, such as are found in optical components, can be measured. For some diffusely reflective surfaces, the angle can even be as great as 80 degrees.

Interferometric sensors also have very low measurement uncertainty. When integrated into a coordinate measuring machine, for example, optical roughness measurements can be reproduced precisely at the same position on the workpiece surface. Interferometric point sensors, however, have a short working distance.

Laser distance sensors and chromatic focus sensors are also available as line sensors. The advantage of a laser line sensor is rapid measurement of large areas with average precision.

The main advantage of line sensors using the chromatic focus principle is the combination of high measuring speed and

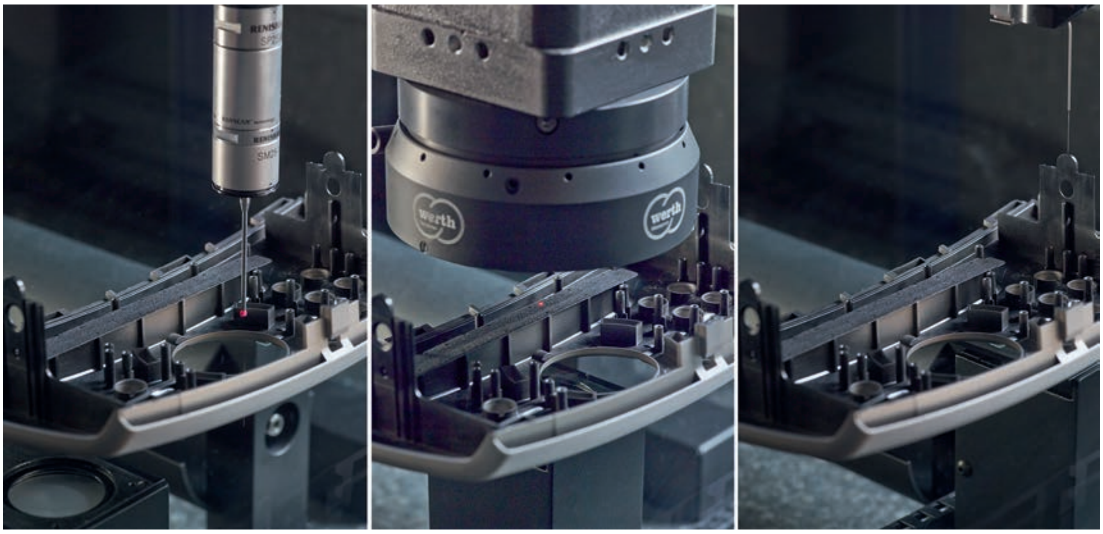

Figure 1. Tactile (left), optical (center), and tactile-optical (right) multisensor systems (© Werth)

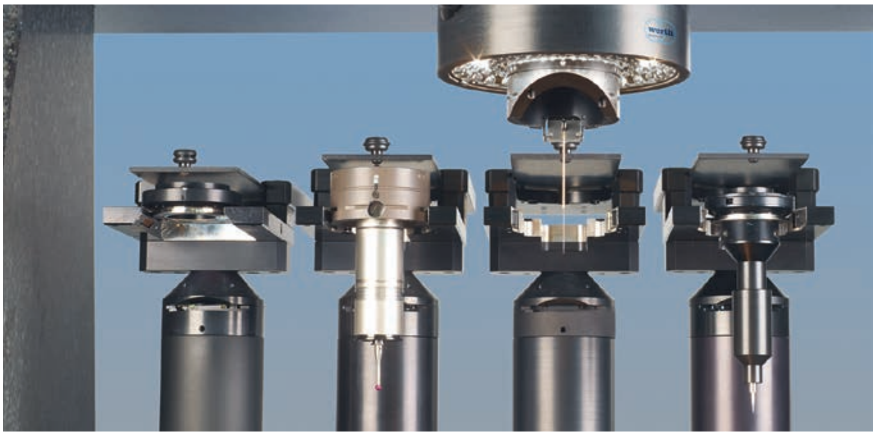

Figure 2. Using the Werth multisensor system, for example, an auxiliary lens for the integrated laser distance sensor, conventional probe systems, fiber probes, and contact stylus sensors can be changed out with zero offset in front of the beam path of the image processing sensor. (© Werth)

low measurement uncertainty with nearly no dependence on the surface condition. In addition to a measurement point cloud, they provide an intensity image for measurements using image processing. The sensor offset is eliminated here as well.

Area sensors using the focus variation principle have the same advantages and disadvantages as their associated point sensors, while confocal area sensors have very low measurement uncertainty and are largely independent of surface condition.

The main advantage of conventional tactile-electrical sensors is their full 3D capability. Additional benefits of the patented Werth Fiber Probe (WFP) tactile-optical sensor include its small stylus tip, negligibly low contact force, and low measurement uncertainty (Figure 1). The Werth Contour Probe (WCP) enables contour and roughness measurements that conform to standards on multisensor coordinate measuring machines.

Multisensor Systems Have Many Advantages

Firstly, the multisensor coordinate measuring machine replaces several single-purpose machines. For measurements using conventional measuring equipment, a dedicated gage is needed for every dimension, or a dedicated multi-position measurement device is needed for every type of workpiece. Multisensor coordinate measuring machines, in contrast, provide complete solutions for complex measurement tasks on different workpieces using a single measuring machine. The combination of various sensor principles means that all elements are measured in the same coordinate system and can be computationally linked for analysis. Only one measurement sequence is created by means of which the workpiece can be measured completely in a single setup.

When many sensors are used, the combined measuring range that remains after accounting for sensor offsets may be significantly smaller than the measuring range for a single sensor. This is avoided by the Werth multisensor system, where different sensors can be changed out at the same mounting point in front of the image processing beam path (Figure 2). Alternatively, dual-ram machines like the Werth VideoCheck FB DZ maximize freedom of movement, as the Z ram that carries the sensors that are not active can be moved out of the measurement area prior to measuring.

With a multisensor coordinate measuring machine, the optimal sensor is available for each element to be measured. Geometric properties such as dimensions, position deviations, and roughness can be determined by linking the geometric elements measured with the various sensors. Among the sensors that are capable of performing the measurement, the fastest is selected. In order to further optimize measurement time and precision, all elements for which this sensor is best suited should be measured in sequence without changing out the sensor.

Multisensor Systems in Practice

One example for the benefits of multisensor coordinate measuring machines is the use of an image processing sensor at low magnification to determine positions for tactile measurements.

For plastic workpieces, the edges can be measured using the image processing sensor, then the flatness of gasket seats can be measured using the WLP integrated in the beam path. Shafts and turned parts are a classic example of a multisensor system application. The diameter is measured with the image processing sensor, lengths with conventional probe systems, and roughness with the WCP. For plug connectors, in contrast, the geometry of the plastic housing and the rough position of the pins can be determined using the image processing sensor. The exact positions of the pins are then measured using the WFP.

With multisensor coordinate measuring machines, complete measurement of the workpiece in a single setup is possible. All sensors are calibrated to each other, so they can be used in any desired combination. Sensor changes can be performed automatically during the measurement. This means that not only is there a sensor available for every geometric property, but the optimal sensor combination can also be used for complete measurement of any workpiece. ■

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