Practical Tip

USING MULTISENSORS TO CAPTURE ENTIRE GEOMETRIES

Scanning With and Without a Defined Path

Scanning is a way to capture the geometries of workpieces with a lot of points in a reliable process, to measure dimensions, shape, and orientation in a functionally correct manner. Contour scanning uses a feedback control algorithm in conjunction with the sensor and the coordinate measuring machine. By using information about the nominal contour, scanning speed can be increased significantly.

Scanning modes are available for most tactile and optical sensors on modern coordinate measuring machines. This applies to conventional "measuring" probes, tactile-optical microprobes, optical distance sensors, and image processing. Contours can thus be captured automatically for workpieces with different sizes and tolerances. The user can choose among various scanning modes.

Scanning Without a Defined Path

When scanning without a defined path, also often known as scanning with feedback control, the sensor tracks an unknown contour while the coordinate measuring machine controller maintains a target level of deflection. This operating mode is used if there is no defined path available or if it is not sufficiently exact. The method therefore makes sense particularly for sensors with a measurement range that is relatively small in comparison with the workpiece tolerances.

If sensitive workpieces cannot be measured optically, then the alternative of tactile measurement often requires very low contact force to avoid damage to the surface. The deflection of the probe can be kept low by using a feedback control process. If the scanning speed is too high, there is also a risk that the probe element will be deflected too much or lose contact

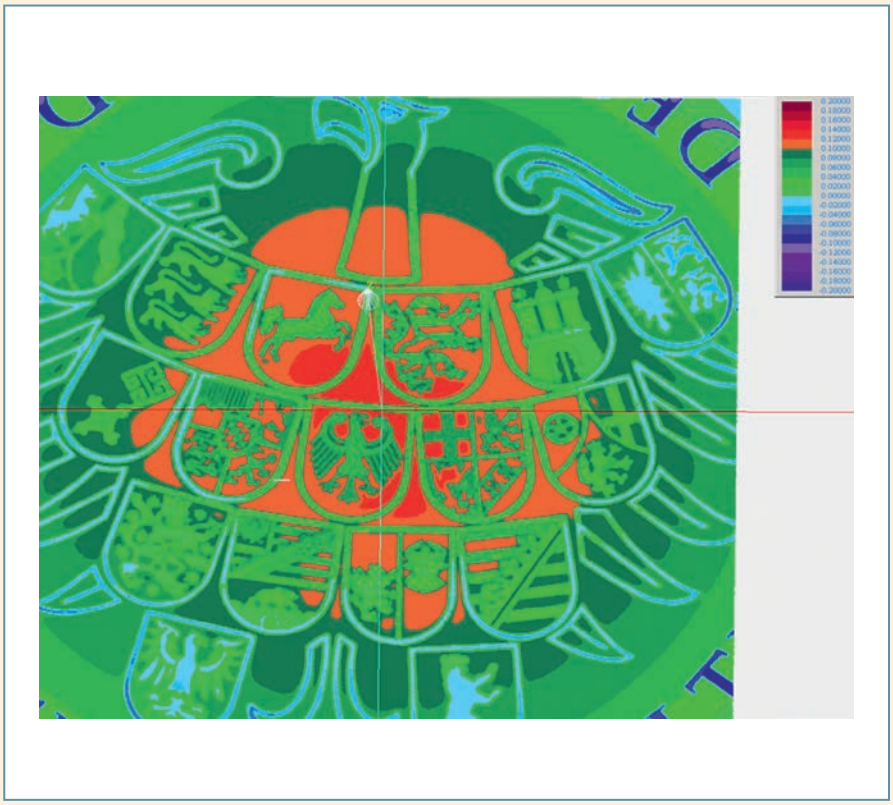

Figure 1. Scanning an embossing die for coins along a defined path without feedback control, using an optical distance sensor (color-coded deviation from a best-fit plane, as the model was understandably not available)

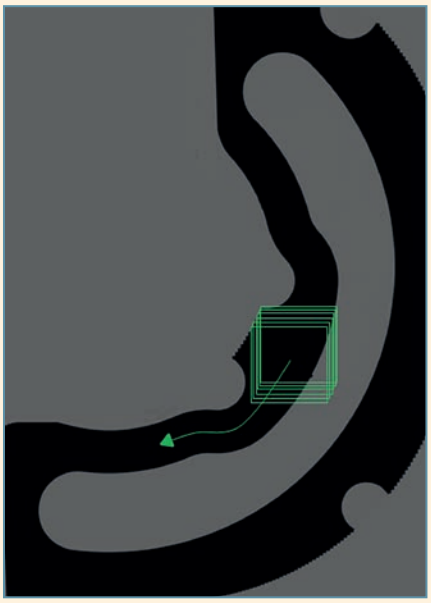

Figure 2. When scanning along a defined path with an image processing sensor, images are captured at the maximum camera frequency while the sensor follows the defined path.

with the workpiece when changing directions during the scanning process.

The scanning speed is therefore also limited by the control software. Furthermore, the shape of the scanned contour influences the speed. The more often the direction is changed, and the greater the deviation from the previous direction, the stronger the control response must be and the slower the scanning speed. A cylindrical shaft, for example, can be scanned very quickly, while scanning a gear takes significantly more time.

The quality of the surface also plays a role. Smooth surfaces can be captured more quickly. The effect of the desired measurement point density on the scanning speed should also be considered automatically by the measurement software. The significant advantage of scanning without a defined path is greater flexibility combined with a high level of process certainty, particularly for unknown workpiece contours.

Scanning With a Defined Path

Uncontrolled: If a defined path is available, this information can be used to implement the scanning process. In the simplest case the scanning path is defined by a contour that has been measured in advance by using a CAD model, by measuring or entering nominal elements, or by using other sensors on a multisensor coordinate measuring machine. Time-consuming calibration can be eliminated and a very high measurement speed can be achieved. One prerequisite is that the measurement range of the sensor is greater than the expected deviations between workpiece and nominal geometry (Figure 1). This can be estimated using the workpiece tolerances. The measurement range of the sensor should be about twice as great as the workpiece tolerance, to be on the safe side. The main advantage of this operating mode is the measurement speed, but no measurement points can be recorded if the deviations between the actual values and the target values of the workpiece are too great.

Feedback control: Feedback-controlled scanning along a defined path combines the advantages of both methods. Here again the scanning path is principally defined by a contour from a CAD model, nominal element, or multisensor measurement. While scanning rapidly along this defined path, the utilization of the measurement range of the sensor is monitored automatically and continuously. The path is corrected and the speed is reduced only if defined intervention limits are exceed. Rapid, reliable measurements are possible using this feedback-controlled scanning method along a defined path, including for sensors with a small measurement range and workpieces with wide tolerances. If a defined path is available or can be created, then this operating mode should be used wherever possible.

Tactile and Optical Scanning

All tactile sensors with their own measurement range can be used for scanning with and without a defined path. For widespread conventional scanning probes or the patented WFP/S and 3D-WFP fiber probes from Werth Messtechnik, Giessen, scanning with feedback control and a defined path, in particular, opens up a variety of potential applications.

For example, when scanning control cams with a probe, abrupt changes in direction will occur that can be handled with rapid scanning along a defined path. The severe deviations from the nominal that occur in raw or unfinished parts are also handled at high speed using this method.

Microgears and fuel injectors are often measured with the WFP/S fiber probe. These workpieces also deviate very often from the specification to be calculated. With feedback-controlled scanning along a defined path, the contour can be captured reliably despite these deviations and the measurement speed can be increased.

Optical distance sensors often permit uncontrolled scanning of workpiece topographies at maximum speed by utilizing their relatively wide measurement range. According to the manufacturer, the Werth Laser Probe WLP or the Chromatic Focus Probe CFP, for example, do well when scanning without feedback control along a defined flat surface to determine the surface topography (Figure 1).

The image processing sensor can be used with feedback-controlled scanning to measure unknown contours on punching dies, for example. A new method of scanning a defined path without feedback control provides previously unachievable measurement speeds. While the image processing sensor follows the defined path it captures images at the maximum camera frequency (in a patented method) and precisely overlays them (Figure 2). This also makes it possible to further reduce measurement uncertainties by averaging the captured images.

While the main benefit of scanning without a defined path is its flexibility, scanning without feedback control along a defined path provides the highest measurement speed. Controlled scanning along a defined path combines these two advantages and provides process reliability and a wide range of potential applications. □

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