



Measure with Vision

Vision dimensional metrology can offer unique productivity enhancing opportunities. BY ALLEN J. CIUS

Vision dimensional metrology should not be confused with machine vision. While both are based on image analysis, vision dimensional metrology systems generally are off-line or near-line systems, collecting dimensional data points in 2-D or 3-D, analogous to those collected by coordinate measuring machines (CMMs). By contrast, machine vision systems generally are located in-line, snapping images of moving parts for real-time examination of features of interest.

TECHNOLOGY OVERVIEW

Today, parts requiring dimensional measurement and inspection are becoming extremely small. Some, on the nanoscale, are built up from the molecular level.

These parts are too small for measurement via conventional CMMs because contact probes typically cause enough displacement to prevent accurate results.

As applied, vision dimensional measurement systems image the features to be examined with a digital camera that is driven into position using computer numerical control (CNC) technology, operating much like a CMM. Applied in this way, the focal point of the objective lens is analogous to the center of the CMM's stylus.

A magnification level is determined, the workpiece is illuminated to optimize contrast and an appropriate lens train is selected. The feature of interest is programmed into the system using appropriate software tools such as edge detection or pattern detection. In some systems, auto-focus technologies that correlate depth of field to known Z-axis values can generate 3-D measurements.

Because the workpiece view can be magnified to any power, there is virtually no lower limit to the size of features that can be measured, provided that the optics are properly

◀ Some vision dimensional metrology systems have streaming vision technology, which replaces conventional digital cameras and associated lighting with stroboscopic illumination, enabling a progressive scanning camera to capture images while the workpiece is in motion. Source: Mitutoyo America Corp.

implemented. For example, there are CNC vision measuring systems capable of measuring radii, holes and other features with a total tolerance bandwidth of 0.5 micrometer.

Interestingly, the pixel count of a vision metrology system's digital camera is not a limiting factor because almost all the charged-coupled device (CCD) pixels are applied against the magnified image being scrutinized. This is in contrast to machine vision systems, which typically image fields of interest measured in square inches.

ILLUMINATION

Workpiece illumination is crucial to the function of vision metrology tools. These tools rely on contrast to automatically find edges and light color to resolve color-based features. The three basic types of illumination include stage, through the lens (co-axial) and programmable ring.

Stage lighting is simplest and performs much like lighting used in optical comparators. Coaxial lighting is directed to the workpiece through the optical train and is mainly used to illuminate a workpiece surface.

Ring lighting is the most flexible. Some ring designs employ halogen/fiber optic illumination; others use LEDs. For example, rings can make use of red, green and blue LEDs, mixing the colors to obtain white light. A choice of colors makes it easier to define edges and textures and to distinguish colored features. Color and intensity of light can be programmed by quadrant.

STREAMING VISION

Streaming vision is a new technology that in certain applications can greatly impact the throughput of vision metrology. Streaming replaces conventional digital cameras and associated lighting with stroboscopic

illumination. This enables a progressive scanning camera to capture images while the workpiece is in motion. When the stage carrying the part reaches a measurement point, a short, high-intensity flash freezes motion to record a key coordinate.

UNIQUELY PRODUCTIVE

After their introduction three decades ago, vision metrology systems have become the preferred method for measurement and inspection in certain applications.

- Where soft or delicate workpieces would be deformed or otherwise damaged by the physical contact of CMM probe scans.
- For measurement of very small features, typically less than 30 micrometers in diameter, too small for probes to make effective contact.
- When measurement would be too time consuming for a CMM; for example, when hundreds of points need to be sampled to determine wall thickness.

An illustration of the unique capabilities of vision dimensional metrology is the inspection of multi-channel medical tubing. Such tubing is constructed to include two or three bores within a single tube of extruded polymer material. These bores are analogous to small pipes; one may be conveying plasma, the other a medication.

Measurement would determine minimum wall thicknesses of the bores within the tube. The routine would require cutting multiple sample cross sections and palletizing them for loading into the vision machine. The machine would be programmed to take into account the different heights and foci of the samples. Pattern recognition would automatically locate the bores in each cross section. Next, hundreds of data points automatically would be taken along the inner diameters of each bore, providing data for calculation of minimum distances between bore walls.

A conventional CMM may not be able to handle this task—the flexible, soft nature of the tube making accurate probe contact impossible. And, in any case, the number of data points



Vision dimensional metrology systems are an effective method for measurement and inspection for applications in which workpieces are delicate, easily deformed or very small. Source: Mitutoyo America Corp.

required would be too large to sample in a reasonable amount of time.

An example of the use of streaming vision might be the measurement of corrugated plastic or paperboard. The challenge is presented by the workpiece's linear aspect. Measuring the thickness of each facing sheet on a continuous basis would be accomplished by an arrangement whereby the end view of a sectioned

piece is passed by the streaming camera. The camera would record key points with the workpiece in motion—requiring only a fraction of the time needed by conventional vision metrology.

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