

Technology

## Optical (Big, Bold, Fast) Metrology

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Step into the optical metrology world and one thing is clear. This vibrant business sector continues to innovate new designs of portable coordinate measuring machines (PCMMs) for the inspection of large components and fixtures. Large-scale manufacturers are still on the hunt for updated optical methods to address in situ 3D measurement over large surface areas found in aerospace, shipbuilding, automotive and other industries. The need to carefully analyze surfaces in detail is driving the trend for better optical measurement tools that provide bigger data sets, as opposed to the old-style check fixtures with hard gaging.

New camera-based optical photogrammetry systems are introducing new designs that are major departures from older versions of the traditional optical toolsets. As these systems are used in harsh industrial environments or in remote outdoor settings, engineers place a special design focus on the robustness and resistance of these systems to the impact of mechanical stress such as vibrations or shock. During the research and development phase, protracted testing is used to check system accuracy over an entire measuring volume. Newer systems embed two high-performance cameras inside a robust housing, allowing for inspection, tracking and positioning even in rough production environments with dust and vibrations.

### New Designs, Fast Returns

Modern optical systems based on photogrammetry come in many different configurations. A newer design will contain two high-resolution, 8-megapixel digital cameras in a closed camera beam. These integrated digital cameras are capable of rapidly capturing any type of target placed on the component to be measured or on a handheld probing device. The generated images are processed automatically and 3D coordinate data is calculated in real time. Issues like vibration, noise and position changes that have plagued metrologists for years are no longer problematic. There are optical systems on the market that offer a new technology called dynamic referencing, which enables the system to automatically detect and compensate for these environmental disturbances by optical tracking. This functionality guarantees constant process stability, even if the system is moved during a measurement session.

### More Advances

The technology needle has also moved forward in terms of accuracy. There are optical measurement systems in the market now that can measure objects up to five meters in volume with an accuracy range of 40 to 80 microns. A new capability for camera-based solutions is the ability to simultaneously capture multiple points, and expand their usage into load testing and fatigue testing in laboratory settings, as well as other static and dynamic applications. Combine these advancements with dynamic referencing, and the user now has a toolset that can detect geometric conditions with precision, and be used in a high-activity industrial setting with minimal or no downtime.



3D data from the door and side panel will be captured into their respective coordinate system and made available for the assembly process with adapters.

## Making Quick Work

Any technician who has ever tried to align a component quickly and accurately can appreciate the complexity of the task. A good example is positioning a car door in a side panel. This is not an easy job, but an undertaking car manufacturers struggle with every day in the prototyping process. Each time a screw is adjusted on one side of the door, and then checked on the other side, it is warped. This exercise can be a lengthy, tedious process, normally taking up to 30 minutes to align a door based on its CAD data and fit. This scenario also presumes that no one touches anything during the procedure.

Thus enters the camera-based optical tracking system. These photogrammetry solutions are intrinsically easy to set up, in the same way a photographer sets up their gear for a photo shoot. A single operator mounts a camera bar on a tripod and is ready to go. Rollers can also be attached to the tripod for easier movement around the shop floor. The photogrammetry system is placed in the best position for line of sight measurement, and the sensor is oriented toward the object to be measured. The whole setup process is completed in minutes. New systems incorporate sensors that are temperature controlled, meaning the sensor can regulate its own thermal stability.

Now back to the task of positioning the car door in the side panel using an optical technique. First, an operator would signal the door with some simple targets. Next, critical features of the door would be captured using a handheld probe for the pre-alignment procedure. The same process would be applied to the side panel. Both components are now captured into their respective coordinate system.

The camera-based technology enables simultaneous measurement of multiple points on those components and also tracks 6DoF bodies dynamically. Measurement software shows the progress of the alignment process in real time with the use of visual deviation flags on the computer screen for guidance. The operator can use the data to turn a screw and adjust, then verify when the targeted position is reached. In short, the deviation flags act as indicators for rapid alignment of the components within a few minutes.

## Harsh Environment, No Problem

A classic consideration of any metrologist is whether or not an industrial environment is stable enough for measurement. Based on the size of the object or assembly, another concern is if the metrology system will have to be moved during a session. Those two lingering issues have been addressed with dynamic referencing, as discussed earlier. Using targets on the automobile's side panel as reference points, a photogrammetry system can compensate for movement of the sensor. This same technology can also compensate for measuring an object in an area where there is vibration or other factors contributing to an unstable environment.

As the line-of-sight areas of the object or assembly are measured simultaneously, every shot is directly being transformed into a global coordinate system. Measurements are taken reliably, even if a worker touches the part or shakes a fixture. No manual realignment is necessary as the photogrammetric system remains online and continues to acquire data while day-to-day workplace activities occur during the session.

## The Emerging Alternative

The providers of optical metrology solutions are certainly following mainline trends in the industry: easier operation of the hardware, smarter software, and faster data acquisition. These features, coupled with reliable and stable measurement results of newer camera-based PCMMs, provide an alternative to traditional gages or touch-probe-only solutions. In addition to precision inspection, these systems can also monitor and simplify assembly processes, and help guide an operator through positioning and alignment work with immediate feedback. Apart from accelerating the measurement process, today's camera-based optical systems are operating significantly faster in many other static and dynamic applications, resulting in time-savings and cost advantages for those who tap into the new paradigm.

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