Capture 15,000 Points Per Second By Equipping CMM with Laser Probe

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Laser scanners capture thousands of points every second, drastically improving reverse engineering and inspection speed and accuracy. As a result, many companies are either replacing their Coordinate Measurement Machines (CMMs) with laser scanners or purchasing laser scanners instead of CMMs as they expand their operations. But other companies are looking at the large investments they have made in their existing CMMs and asking if they can be preserved or enhanced by equipping them with a laser probe. The answer is yes, a CMM can be quite easily equipped with a laser probe at a cost that typically runs only 25% of the cost of a new laser scanner. A laser probe can reduce the time needed to measure complicated parts from hours or even days to just minutes. The operator can convert from laser probe to conventional touch probe in a matter of minutes, so none of the functionality of the original CMM is lost. This article will explore the advantages of using a laser probe with a CMM and explain how it can be accomplished with minimum trouble and expense.

CMM's wide popularity

Originally introduced in the late 1950's by Ferranti, CMMs began to achieve wide popularity during the 1970's when they became the gold standard for quality control and reverse engineering. CMM's key advantages include the ability to measure individual points to a high level of accuracy and to move from sample location to location under computer control. Trends of the past decade, however, have highlighted several weaknesses. Part geometry has grown increasingly complicated and, in particular, 3D contours are becoming more and more common. As geometric complexity grows, the number of points required for accurate measurements increases at an exponential rate. Frequently, tens of thousands and sometimes hundreds of thousands or even millions of points are required to accurately model geometrically complicated parts. The result is that the time needed to capture points one by one has grown to days or sometimes weeks for complicated parts. A contact probe is also limited in the geometries that it can accurately reverse engineer. Some parts have indentations that are too small for the probe to enter. Another trend that is affecting the usefulness of CMM machines is the increasing use of new materials that present problems for contact probes used on a conventional CMM. Some parts are so flexible that it is very difficult to contact the surface with a touch probe without creating an indentation that detracts from the accuracy of the measurements. Other parts have surfaces that could easily be scratched or otherwise damaged by a CMM probe.

Rise of laser scanning

Laser scanning is a new technology that can easily overcome these problems, making it ideally suited for today's quality control and reverse engineering challenges. Laser scanning systems work by projecting a line of laser light onto surfaces while cameras continuously triangulate the changing distance and profile of the laser line as it sweeps along, enabling the object to be accurately replicated. The laser probe computer translates the video image of the line into 3D coordinates, providing real-time data renderings that give the operator immediate feedback on areas that might have been missed. Laser scanners are able to quickly measure large parts while generating far greater numbers of data points than probes without the need for templates or fixtures. Since there is no contact tip on a laser scanner that must physically touch the object, the problems of depressing soft objects, measuring small details, capturing complex free form surfaces are eliminated.

Instead of collecting points one by one, the laser scanner picks up tens of thousands of points every second. This means that reverse engineering of the most complicated parts can often accomplished in an hour or two. Laser scanning can reverse engineer parts that are so complex that they would be practically impossible one point at a time. Finally, the software provided with the scanner greatly simplifies the process of moving from point cloud to computer aided design (CAD) model, making it possible in minimal time to generate a CAD Model of the scanned part that faithfully duplicates the original part. Special, but readily available software can be used to compare original design geometry to the actual physical part, generating an overall graduated color error plot that shows in a glance where and by how much, surfaces deviate from the original design. This goes far beyond the dimensional checks that can be performed with touch probes on CMMs.

Need for laser probe

While many companies have purchased laser scanners, others have already made considerable investments in CMMs that are still in excellent condition. Recognizing that the machine base and motion control system of a laser scanner is nearly identical to that found on a laser scanner, they have asked if they could simply upgrade a CMM with a laser probe. Recently, laser probes have become available for existing CMM machines. The laser probe is mounted to the CMM in place of the traditional contact probe. The laser probe comes with a computer that collects the laser scan data and converts it to a 3D point cloud. Integrating the laser probe with the CMM is relatively simple because a laser probe, unlike typical touch probes, does not need to be in an exact location to measure because of its large field of view. It just needs to know exactly where it was when the data was collected so that the scan data can be accurately positioned in space. With a depth of field ranging from one to several inches, all that matters is that the laser probe pass through the area of interest on the part. The most popular method of integration is for the CMM's motion system to guide the probe while probe computer monitors the encoders to track position. Another option is for the laser probe's PC to actively control the CMM position, even to the point of using feedback from the probe to keep the part surface in its field of view.

The laser probe can be operated in either joystick mode or programmed for automated inspection. In the joystick mode, the laser probe is attached to the CMM and is controlled by its own PC, which is independent of the CMM's control system. The operator observes the data captured on the probe computer screen, plans and executes the next move, and continues until the desired coverage is achieved. Alternatively, in an installation that includes a communication link between the probe and CMM controller, the operator can set up moves on the probe computer that are sent to the CMM controller and even modified on the fly to track surfaces in response to feedback from the laser probe. This mode also allows for entire part inspection sequences to be stored, recalled and repeated.

Interfacing Mechanics

The first step in interfacing the laser probe to the CMM is capturing the machine position. An encoder interface unit is integrated into the CMM electronics to achieve this. Some motion transports are so accurate the error contribution relative to the probe is small and can be ignored. Many CMMs, however, are designed to tolerate errors that are mapped and stored for recall to correct raw encoder readings.. If the CMM uses this type of volumetric compensation, the native comp table needs to be translated to the probe computer format. The volumetric approach compensates for linearity and squareness errors, but for straightness errors, angle compensation is also required. For straightness correction, it is not practical to simply store large tables of position corrections. Rather, parameters must be stored that characterize the CMM, so that for each position, not only is a corrected x,y,z coordinate developed, but also an orientation is supplied. This allows the corrected x,y,z to be extened to the active work area of the laser probe. If the CMM controller can accept a trigger from the laser probe, the native correction methods can be utilized. If the CMM controller cannot accept the trigger, a laser probe correction must be installed.

The laser probe can be mounted to the CMM in any orientation. Once mounted, the orientation relative to the motion transport must be determined. From then on, the laser controller can develop coordinates on the part surface combining probe reference frame coordinates with motion transport coordinates. To measure the relative orientation between the probe and transport, the laser probe control software uses an alignment utility that calls for the probe to be moved around a sphere to derive the transformation.

Conclusion

All in all, equipping a CMM with a laser probe can dramatically improve productivity by capturing up to 15,000 points per second, dramatically reducing reverse engineering and inspection time. The ability to capture complete geometries rather than a limited number of points improves accuracy. The non-contact laser probe easily measures free-form shapes, delicate parts and difficult geometries. Laser Design's quick and simple CMM laser kit is the lowest cost way to take advantage of laser scanning technology.

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