Application Notes AP1112

Laser Non-contact and High-Resolution Dial-indicator for Spindle run-out and 5-axis machines

I. What is the problem?

Dial-indicators have been extensively used to check the machine geometry accuracy. However, because of the low resolution and the mechanical contact, its application for precision measurements are rather limited. For example, measure the spindle run-out at high RPM, measure the angular accuracy of the rotational A-, B-, or C-axis of a 5-axis machine, measure the squareness between axes and the straightness of travel. The laser non-contact, high-resolution dial-indicator can perform all of the above with much higher accuracy.

II. How the laser non-contact and high-resolution dial indicator solves the problem.

The laser non-contact and high-resolution dial-indicator is an add-on package to the MCV-500 laser calibration system. The combined system can be used to perform non-contact displacement measurement of a polished surface, such as a flat-mirror or a cylinder. Hence it can be used as a dial-indicator without mechanical contact and with high accuracy. The analog output bandwidth is 800,000 Hz. The digital data collection rate is 1000 data/sec with the PCMCIA card and 800,000 data/sec with the IBM PC interface card.

III. How it works.

A unique property of the MCV-500 laser calibration system is the single aperture optical arrangement. Since both the outgoing laser beam and the return laser beam are using the same aperture, it is possible to use a flat-mirror as the target. By aligning the flat-mirror to be perpendicular to the laser beam, the mirror motion along the laser beam direction can be measured. The mirror motion perpendicular to the laser beam will not displace the laser beam, hence not effecting the alignment on the measurement.

A typical application is to measure the accuracy of a rotational angle (A- or B- or C-axis) of a 5-axis machine. As shown in Fig. 1, mount a flat-mirror parallel to the z-axis and program the machine to move along the z-axis. Any angular errors

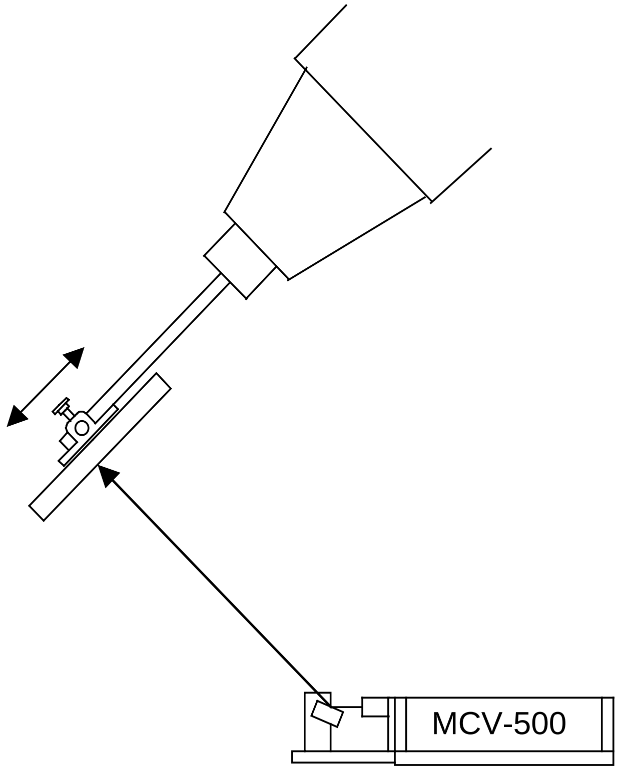

Fig. 1 Non-contact measurement of rotational angle of a 5-axis machine

will be measured as displacement errors along the z-axis movement, and the angular error can be calculated as the ratio of measured displacement error divided by the travel distance along the spindle direction. Using this technique, the rotational angles can be calibrated and compensated. Other applications are: replacing a

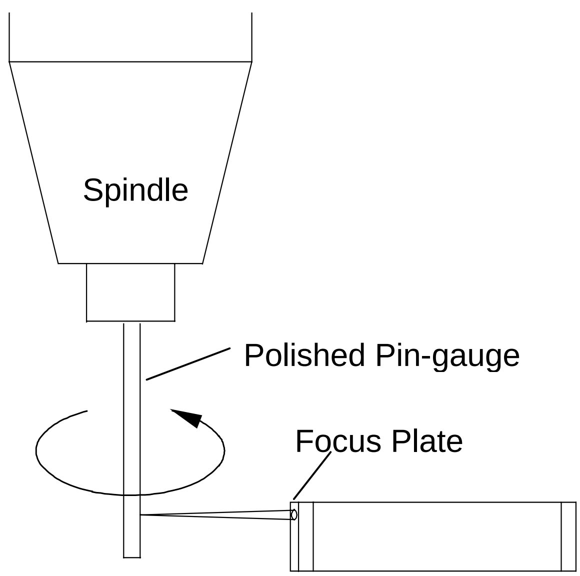

Fig. 2 Non-contact measurement of spindle runout

mechanical straightedge by an "optical" straightedge (see ASME B5.54 Section 5.8.2.2); replacing a mechanical square-edge by an "optical" square-edge (ASME B5.54 Section 5.8.4.1), etc

Using a focus lens to focus the output laser beam to a reflecting surface, any polished metal surface can be used as target. As shown in Fig. 2, a polished pin-gauge (0.5" to 1" diameter) is mounted on a spindle and the laser system is mounted on the bed. A 2" focus lens is used to focus the laser beam on the pin-gauge. Rotate the spindle, the distance variations between the laser system and the pin-gauge surface or the spindle run-out, can be measured. For low RPM a digital display can be used to read the run-out. For high RPM an oscilloscope can be used to view the run-out or a digital interface card can be used to record the high frequency run-out data. A typical digital data showing the spindle run-out with spindle speed varied from 500 rpm to 2500 rpm is shown in Fig. 3.

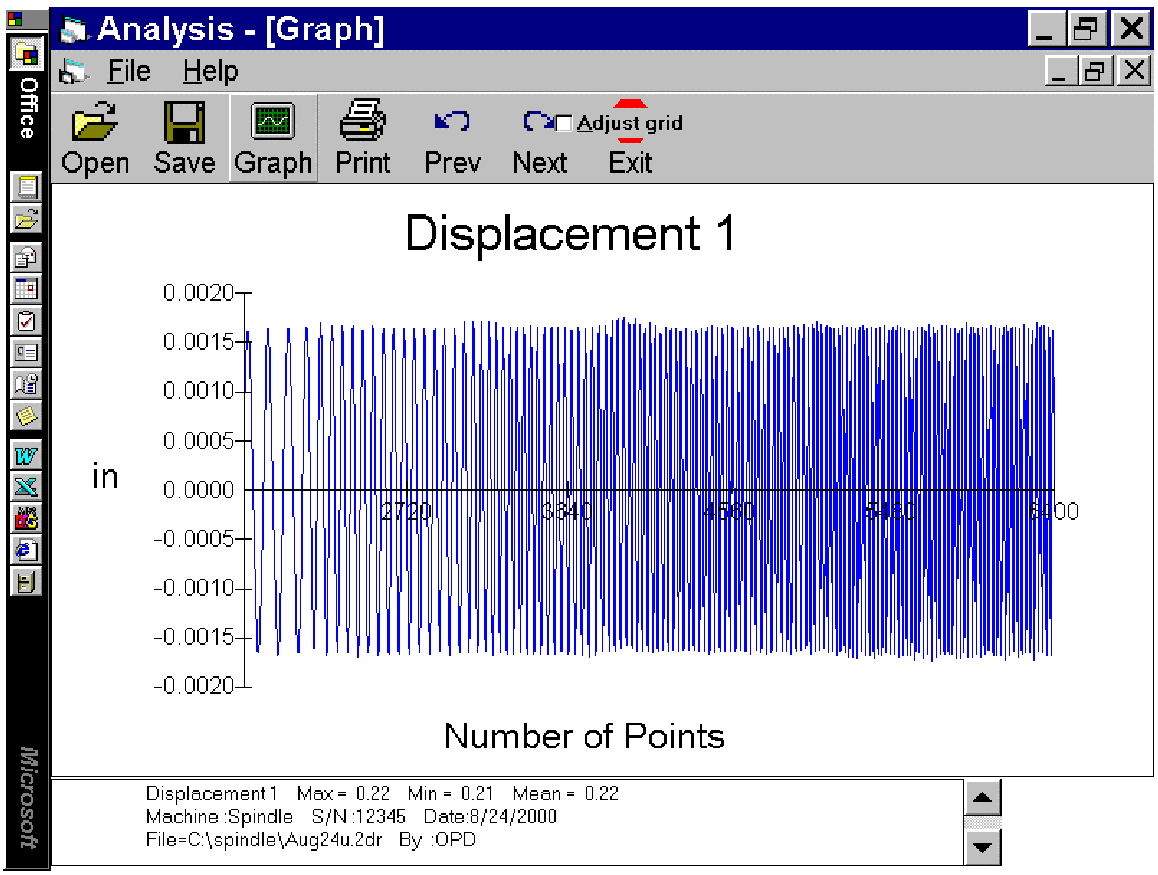

Fig. 3 Spindle run-out at various speeds from 500 to 2500 RPM

IV. Need more information.

Please call Optodyne, Inc. at 310-635-7481 or your local representative