Laser/Ballbar -- Two Instruments In One

I. What is the problem?

For machine tool calibration, usually a laser interferometer is used to measure the linear position accuracy and to generate the compensation files. Also, a telescopic ballbar is used to measure the servo mismatch and to tune the servo controller as well as to check for various geometric errors. Hence, two different instruments are needed for checking the position accuracy and the machine motion control system accuracy.

II. How MCV-500 solves the problem.

The single aperture MCV-500 laser system is based on laser dopplermetry (see Application Notes AP1104). Hence, a flat-mirror can be used as a target. As shown in Fig. 1, pointing the laser beam in the X-direction and mounting the flat-mirror target on the spindle, the X-coordinate of the spindle motion can be measured even with a large Y-direction movement. By repeating the measurement in the Y-direction, the Y-coordinate of the spindle motion can be measured. Assuming the spindle motion is repeatable, the data on X-coordinate and the data on Y-coordinate can be combined to generate the measured circular spindle path as shown in Fig. 2. Hence the MCV-500 can be used for both linear position measurements and for circular tests.

As compared with a telescopic ballbar, the major features of the circular test using the laser are the following.

1. The measurement is non-contact, no cables to worry about, no friction or bearings.

2. The circular path radius can be varied continuously from 0.01 inches to 6 inches.

3. The data rate is up to 1000 data/sec.

4. The measuring speed is up to 4 m/sec.

5. Large alignment tolerance is achieved by using an optical adapter.

6. Linear accuracy is traceable to N.I.S.T.

7. The tangential velocity and acceleration can also be measured and displayed.

8. A compact notebook computer can be used with user friendly Windows™ software for data collection and analysis.

9. The cost is low and affordable.

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. Therefore, the displacement of a circular path along the beam direction can be measured.

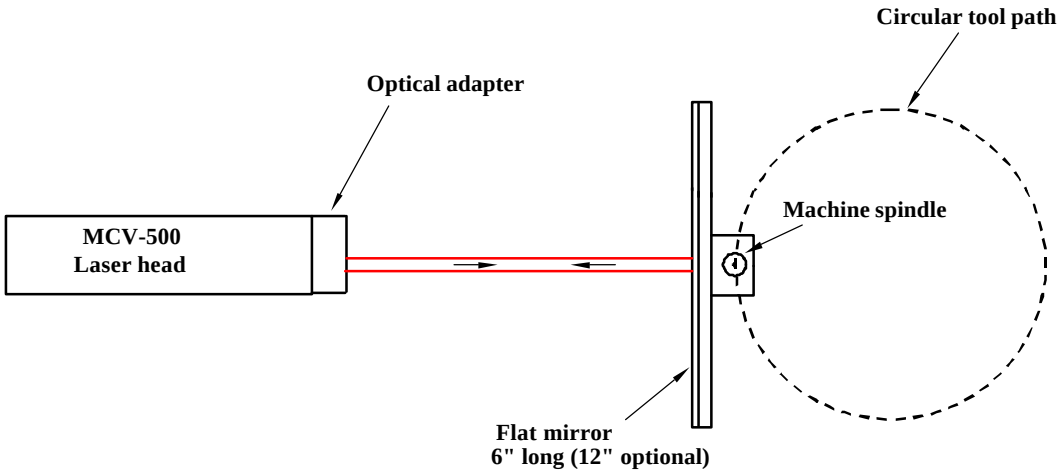

Fig. 1 Schematics of laser/ballbar circular test

A typical setup is shown in Fig. 1. The laser beam is pointing perpendicular to the flat-mirror, and an optical adapter is used to reduce the alignment requirement of the flat-mirror. As the machine spindle moves along a circular path, the flat-mirror remains perpendicular to the laser beam and the displacement along the laser beam direction is measured. Repeat the same measurement along a direction 90 degrees from the previous measurement with the same spindle motion. Combining the data of these two measurements, the measured circular path can be generated. A typical circular test result is shown in Fig. 2.

ISO 230-4
Circular Tests

Data file : July20CL
Test date : July 20, 1998
Machine type: Vertical Milling Machine
Serial number: V1170
Operator: Optodyne

Measuring plan : XY
Direction : X and Y
Feedrate : 20 in/minute
Sampling rate : 30 /sec
Rotation sense : CW
Radius: 2 in

Starting point : X = 20 in
Y = 10 in
Distance from target : 30 in
Measuring radius : 2.000092 in
Circularity : ± 0.000112 in rms.
Radial deviation :
Fxy, max = + 0.000352 in
Fxy, min = - 0.000282 in

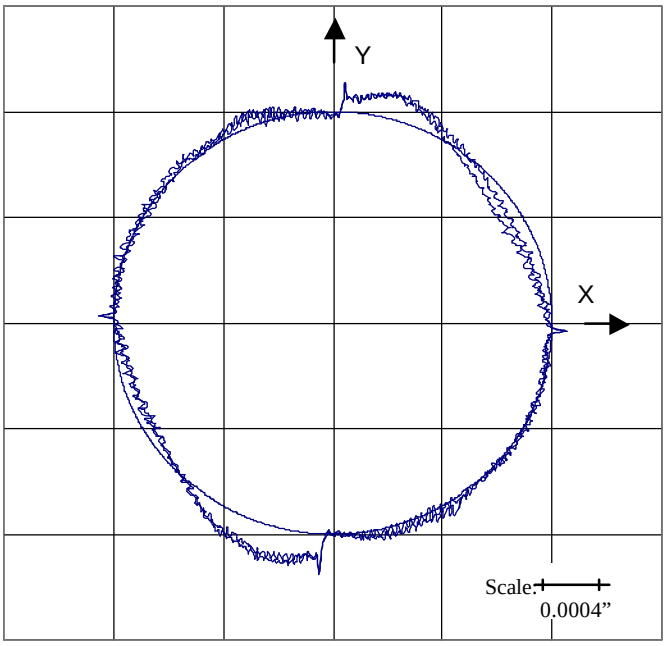

Fig 2, A typical circular test result using Laser/Ballbar

Furthermore, using two laser systems, one pointing in the X-direction and the other in the Y-direction, and two flat-mirrors mounted on the same spindle, the tool path of any shape can be measured. This measured tool path can be used to check the programmed tool path and to eliminate the need for a cmm or a pre-production run.

IV. Need more information.

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