Application Notes **AP1110**

Volumetric Compensation of CMM Machines Using Sequential Diagonal Measurement

I. What is the problem?

For volumetric compensation of a CMM machine, the linear position errors and two straightness errors should be measured for each axis of motion. These measurements are time consuming using conventional laser interferometers. The body diagonal measurement method has been recommended for a quick check on volumetric performance of the machine. However, there is not enough information to identify the error sources and to compensate the repeatable errors.

II. How MCV-500 solves the problem

Conventional body diagonal measurement moving all three axes simultaneously along a body diagonal and collect data at each preset increment. The new sequential diagonal measurement method, moving the X, Y and Z-axis in sequence and collect data after each axis is moved. Hence the position errors due to the movement of each axis can be separated. The collected data can be processed as deviations measured in the body diagonal direction due to X-axis movement, Y-axis movement and Z-axis movement respectively. Hence three times more data is collected for each diagonal measurement. For the four diagonal measurements, there are 12 sets of data to determine the three linear position errors, the six straightness errors and three squareness errors. (See G. Liotto and C.P. Wang, "Laser Doppler Displacement Meter Allows New Diagonal Measurement for Large Aspect Ratio Machine Tool Easily and Accurately" in Proceedings of LAMDAMAP '97).

If all these measurements are repeatable, the measured position errors and the straightness errors can be used to compensate the volumetric errors.

III. How it works

For conventional body diagonal measurement, the displacement is a straight line along the body diagonal. However, for the sequential body diagonal measurement, the displacements is along the X-axis, then along the Y-axis, and then along the Z-axis. The trajectory of the target or retroreflector is not a straight line, and the lateral movement is rather large. Hence conventional laser interferometer will be way out of alignment with such large lateral displacement.

The single aperture MCV-500 laser system is based on laser Dopplermetry (See Application Notes AP1104 and AP1108). Hence, a flat-mirror can be used as a target as shown in Fig. 1. It is noted that with a flat mirror as target, any displacement parallel to the flat-mirror will not displace the return laser beam and will not effect the measurement. Hence only the displacement along the laser beam direction is measured.

Program the machine to move along the body diagonal by sequentially moving X-axis, stop, Y-axis, stop, Z-axis, stop and repeat the sequence until the end of the diagonal point is reached. Repeat the same for the other three body diagonal. The data from these four sequential diagonal measurements will generate 12 sets of data, which will be used to determine the three linear position errors, six straightness errors and three squareness errors.

Currently we are beta-testing the data processing software to determine the effect of pitch, yaw and roll motions and the volumetric compensation schemes.

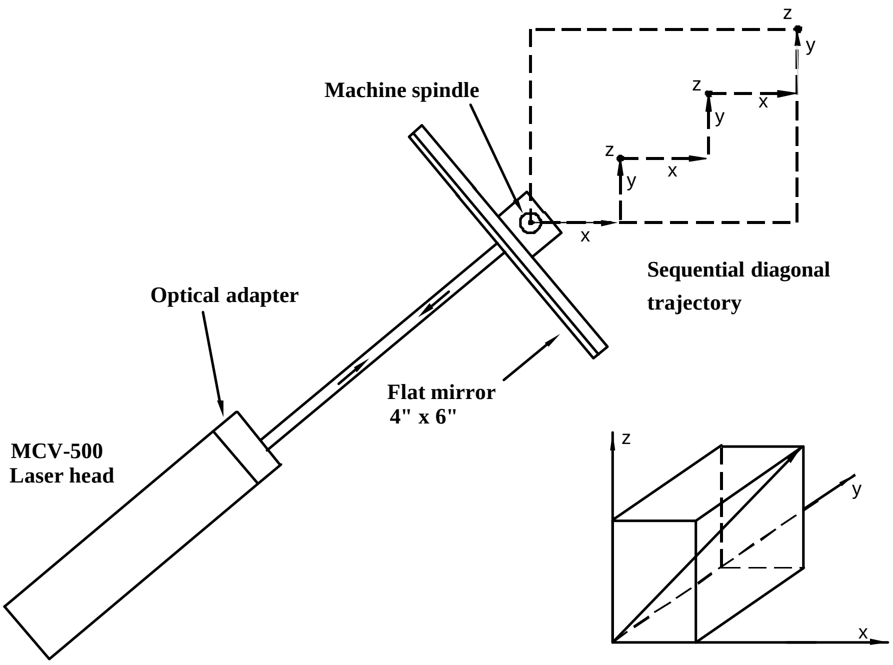

Fig. 1 Schematics of Sequential Diagnal Measurement

IV. Need more information?

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