Sequential Diagonal Measurement (determine linear position errors and straightness errors of all 3 axes with 4 diagonal measurements)

I What is the problem

The laser diagonal measurement method has been recommended by many standards such as the ASME B5.54, and ISO230-2, for a quick check of the volumetric performance of machine tools. However, for large aspect ratio machine tools (machines where one axis is much longer than the other two), it is insensitive to the axes with short travels. Furthermore, the linear errors and straightness errors of all three axes cause the positioning errors in a diagonal measurement. It is difficult to identify the error sources and compensate the repeatable errors.

II How the MCV-500 solves the problem

Conventional laser diagonals require measurements moving all three axes simultaneously along a body diagonal and collecting data at each preset increment. The new sequential diagonal measurement method, suggest moving the X, Y and Z-axis in sequence and collecting 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. Based on a trajectory model, the linear errors and straightness of all three axes can be determined.

For conventional laser diagonal measurement, the displacement is a straight line along the body diagonal. However, for the sequential laser diagonal measurement, the displacement 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 interferometers 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 AP-1104 and AP-1108). Hence, a flat-mirror can be used as a target as shown in Fig. 1. It is noted that with a flat mirror as the 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.

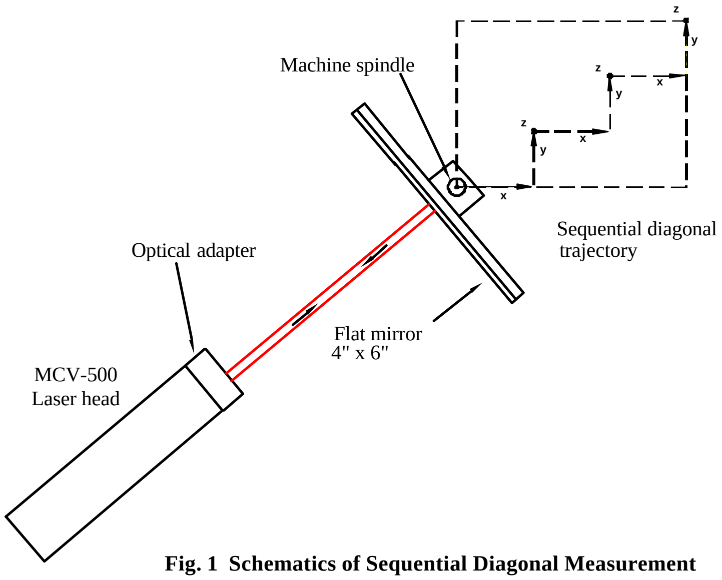

Fig. 1 Schematics of Sequential Diagonal Measurement

III How it works

First, point the single-aperture laser of the MCV-500 system in the body diagonal direction. Align the laser beam in the body diagonal direction to minimize cosine error. Align the flat-mirror to be perpendicular to the laser beam and obtain the highest signal strength. 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. For bi-directional measurements repeat the procedure in reverse moving Z-axis, stop, Y-axis, stop, and X-axis stop. Load the LDDM windows program in a Notebook PC and click on "sequential body diagonal" measurement. Enter the starting point, the ending point, and number of measurement points. The target positions of each movement will be calculated automatically by the software. Click on the "start button" and start the machine movement, the data at each stop will be collected automatically.

Repeat the same for another body diagonal. For large aspect ratio machines, two body diagonal measurements should be enough to determine the linear position errors of all three axes. For regular machines, 4 diagonal measurements are needed to determine the linear position errors and straightness.

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

IV Need more information

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