The Effect of Error in the Home Sensor on Centroid CNC Screw Mapping, Version 1.3

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Conclusion

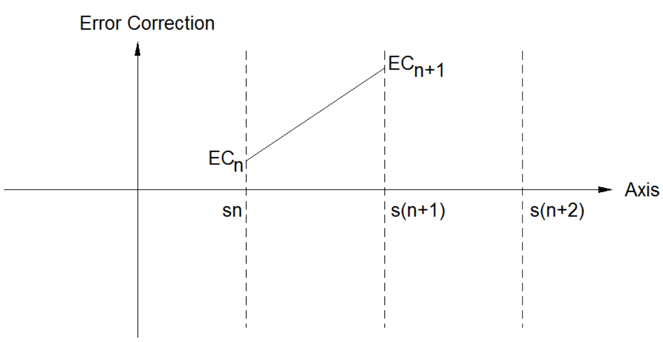
With respect to collecting data for Screw Mapping, the accuracy of the Home position isn't that important.

A Home sensor[2] accurate to ± 0.005 inches causes an error of no more than ±25 micro inches (0.000025) inches.

This assumes a maximum correction between adjacent data points[3] of ±0.005 inches.

With respect to ***using*** the Screw Mapping data, the accuracy of setting Part 0 is absolutely essential.

Proof



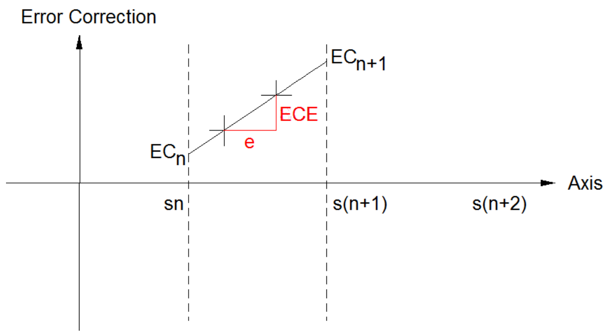
The Centroid Screw Mapping table for each axis consists of data taken at 0.5000 inch intervals. This data is collected while moving away from Home and also towards Home. The physical location of Home on a given axis is set by a Home sensor.

The first sample point being considered is at location sn where "s" is the sample interval. In our case, s = 0.5000 inches. "n" is an integer that both indexes us down the table and moves us along the axis. At location sn we have Error Correction (EC) for location n. The adjacent correction factor is at s(n+1) and is identified as EC_{n+1}. As needed for the proof, we have location s(n+2).

[2] My $3 proximity Home sensors are good to ± 0.002 inches.

[3] I am running a lead screw and see a maximum adjacent data point variation of less than ±0.002 inches.

Case 1: Between Sample Points



Our Home sensor has an error of ±e which causes an Error Correction Error (ECE). The software assumes we are at a given location along the axis but due to e, we are actually shifted over. This shift in location causes the software to generate an Error Correction that is also shifted.

Understanding this problem was the hard part. The math boils down to having similar triangles.

$$\frac{EC_{n+1} - EC_n}{sn - s(n+1)} = \frac{ECE}{e}$$

or

$$ECE = e\,\frac{EC_{n+1} - EC_n}{sn - s(n+1)} \qquad (1)$$

In our case, s = 0.5000 inches. Assume the maximum error correction difference between adjacent sample points is 0.005 inches and that the home sensor has an error of ± 0.005 inches.

$$ECE = \pm(0.005)\frac{0.005}{0.5000}$$

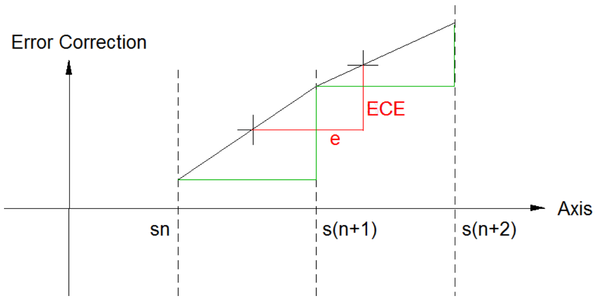
$$ECE = \pm 0.00005\ inches$$

Since position is only displayed to the nearest 0.0001 inch, this error is not noticeable unless the software rounds up.

What saves us here is that the Home sensor error is only 1% of the sampling interval. This means our Error Correction Error will be only 1% of our Error Correction change between adjacent samples.

If the Home sensor error was ±0.05 inches, the resulting Error Correction Error would be $\pm 0.0005\ inches$ so would be visible. Conversely, if the sample distance was 0.05 inches, we would get the same worst case Error Correction Error.

Case 2: Straddling A Sample Point



If our actual position is between sn and s(n+1) but the software is told we are between s(n+1) and s(n+2), our Home error is split between sampling intervals. Consider 3 sub cases.

a) The slope of the second interval is the same as the first. This is just case 1.

b) The slope of the second interval is of the same polarity but smaller. The resulting ECE will be smaller that sub case (a).

c) The slope of the second interval is of the opposite polarity. The resulting ECE will be even smaller than sub case (b) because we are rising up until we reach s(n+1) and then move back down.

I welcome your comments and questions.

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