Aidan Walk
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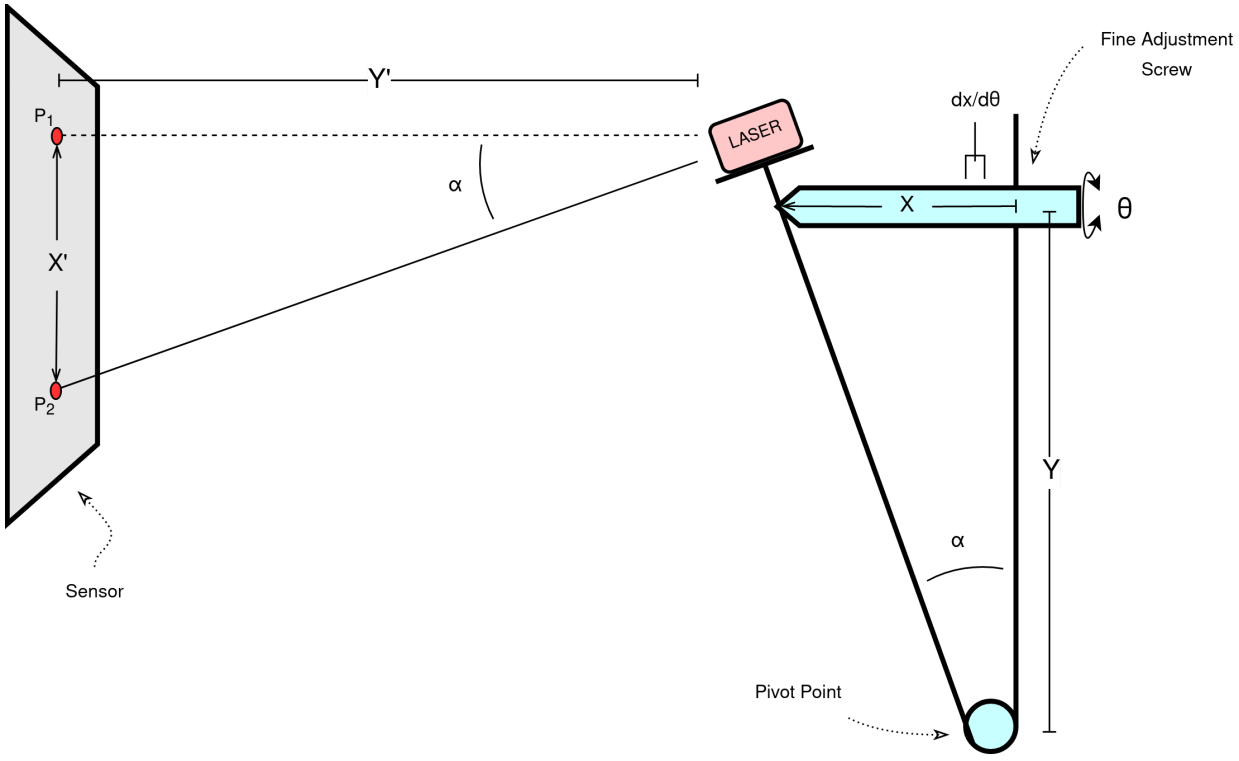
"Jitter" Calibration Report

Setup:

A laser is mounted to a small kinematic mount and aligned to a position sensor that is 255mm away from the laser source (Y').



$Y \cong 38mm$ - Distance from the fine adjustment screw to the pivot point of the kinematic mount

$Y' \cong 255mm$ - Distance from the laser to the sensor

Fine Adjustment Screw: ¼-80 TPI

θ - Describes the rotation of the fine adjustment screw

α - Describes the angle of the laser beam with respect to horizontal

Linear Movement of Fine Adjustment Screw $\left(\frac{dx}{d\theta}\right)$:

The fine adjustment screw has 80 threads per inch, let's convert this to metric and find the linear movement of the screw per 360° rotation:

$$80\ \frac{threads}{inch} = 3.1496\ \frac{threads}{mm} \rightarrow 0.3175\ \frac{mm}{thread}$$

The fine adjustment screw moves 0.3175mm per 360° rotation, thus, X increases by 0.00088mm per 1° rotation of the fine adjustment screw:

$$\frac{dx}{d\theta} = \frac{0.3175mm}{360°}$$

$$X = 8.8 \cdot 10^{-4} \times \theta \quad \left[\frac{mm}{^\circ}\right]$$

Angular Movement of Laser (α):

The angle of the laser depends on the position of the fine adjustment screw:

$$tan(\alpha) = \frac{X}{Y} = \frac{8.8 \cdot 10^{-4} \times \theta \quad \left[\frac{mm}{^\circ}\right]}{38mm}$$

Thus, $\alpha \approx 0.48°$ per 360° rotation of the fine adjustment screw.

Calibration:

The expected change in the Laser's position on the sensor (X') as a function of the rotation of the fine adjustment screw:

$$X' = Y' \cdot tan(\alpha) = Y' \cdot \frac{8.8 \cdot 10^{-4} \times \theta \quad \left[\frac{mm}{^\circ}\right]}{38mm}$$

If the laser is located 255mm away from the sensor, we should observe a change of 4.25mm in the laser's position when the fine adjustment screw is rotated 720°.

$$X' = 255mm \cdot \frac{8.8 \cdot 10^{-4} \times 720^\circ \left[\frac{mm}{^\circ}\right]}{38mm} = 4.25mm$$

The observed change in the laser's position on the sensor after a 720° rotation of the fine adjustment screw:

$$P_1 = -2.34 \cdot 10^{-5} m, \qquad P_2 = 4.27 \cdot 10^{-3} m$$

P_1 is the position of the laser on the sensor before the fine adjustment screw is rotated, P_2 is the position of the laser on the sensor after rotating the fine adjustment screw 720°. Thus:

$$X' = P_2 - P_1 = 4.29mm$$

The Actual spot movement is within 1% of the predicted spot movement.

Recovering α from this test:

$$\alpha = arctan\left(\frac{X'}{Y'}\right) = arctan\left(\frac{4.29mm}{255mm}\right) = 0.964°$$

Since the fine adjustment screw was rotated 720°, the laser moves $\frac{0.964°}{2}$, or 0.482°, per 360° rotation of the fine adjustment screw (0.48° is expected).