In this lab, PID control was implemented on the artemis in order to simulate the simplest control using one of the sensors on the robot.

Estimate Drag and Momentum

To estimate drag and momentum, as said in class,

$$d = \frac{u}{\text{steady state derivative}}$$

and

$$m = \frac{dt_{0.9}}{ln(1s - .9s)}$$

where d and m are the drag and mass respectively.

To find this, I used a constant step response towards a wall at a pwm value of 200 since this was the maximum pwm value from my pid trials. Doing a step response resulted in this time of flight data.

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As seen from the graph, between the two marked points, the speed reaches steady state at a derivative of about 22613mm/s

Looking at the graph, the 90% rise time was about .8s. Therefore,

$$d = \frac{u}{22613\text{mm/s}} \approx 0.000383$$

$$m = \frac{0.000383 * .8s}{ln(1s - .9s)} \approx 0.0001329$$

Now, the A and B matrices are given by

$$A = \begin{bmatrix} 0 & 1\,0 & -\frac{d}{m} \end{bmatrix} = \begin{bmatrix} 0 & 1\,0 & -2.88 \end{bmatrix}$$

$$B = \begin{bmatrix} 0\,\frac{1}{m} \end{bmatrix} = \begin{bmatrix} 0\,-60175 \end{bmatrix}$$

$$C = \begin{bmatrix} -1 & 0 \end{bmatrix}$$

Initialize KF

For discretizing the previously computed matrices, I needed a chosen sample rate to predict filter values at, I chose a sample rate of 15ms, so To discretize these matrices, the formula is

$$A_d = (I + dt * A) = \begin{bmatrix} 1 & 0.015\,0 & 0.957 \end{bmatrix}$$

$$B_d = dt * B = \begin{bmatrix} 0\,-902.7 \end{bmatrix}$$

Next, I needed to

Estimate the noise variables, sigma_u and sigma_z.

$$\Sigma_z = [\,\sigma_z^2\,]$$

$$\Sigma_u = [\,\sigma_x^2 \quad 0\;0 \quad \sigma_v^2\,]$$