The dynamics of in acuator joint space is written as

$$M\ddot{q} + C\dot{q} + G = Au - Kq - D\dot{q} + \Delta$$

where

$$q = [\theta_1, l_1, \theta_2, l_2]^T, u = [\tau_{y1}, f_{z1}, \tau_{y2}, f_{z2}]^T, diag(A) = [a_1, a_2, a_3, a_4], diag(K) = [k_1, k_2, k_3, k_4], diag(D) = [d_1, d_2, d_3, d_4]$$

Δ contains all unmodeled dynamics.

For segment i

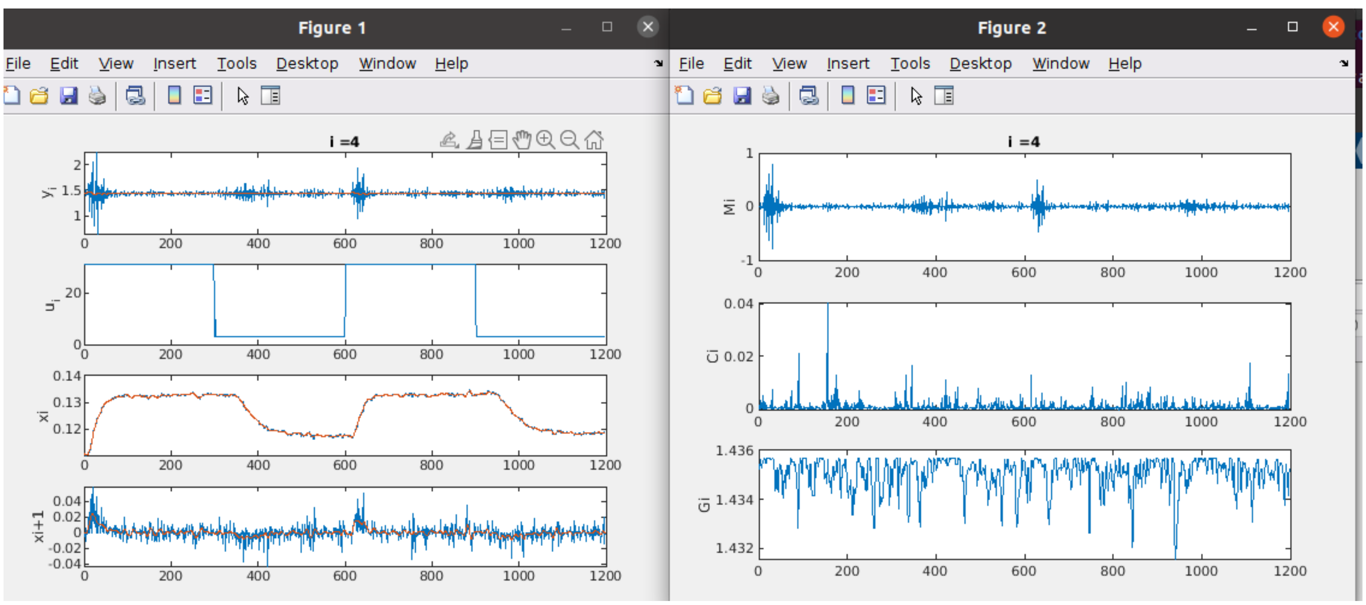
$$\theta_i = (Encoder_{i1} - Encoder_{i2})/0.04, l_i = (Encoder_{i1} - Encoder_{i2})/2$$

$$\tau_{yi} = pd_{i1} - pd_{i2}, f_{zi} = pd_{i1} + pd_{i2} + pd_{i3}$$

Least-square

We set $y = M\ddot{q} + C\dot{q} + G$, then $y_i = a_i u_i - k_i q_i - d_i \dot{q}_i$ and apply 0-order state space model to find the parameter

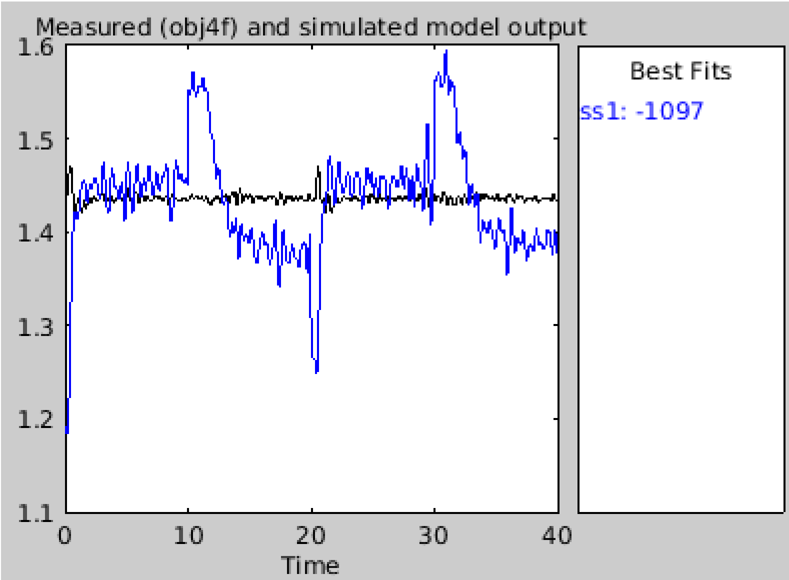
The b_θ variable is corrected and calculated as $b_\theta = \frac{lc_i}{\theta_i} tan(\frac{\theta_i}{2})$. However the result is not correct and presented as follows:



Observations:

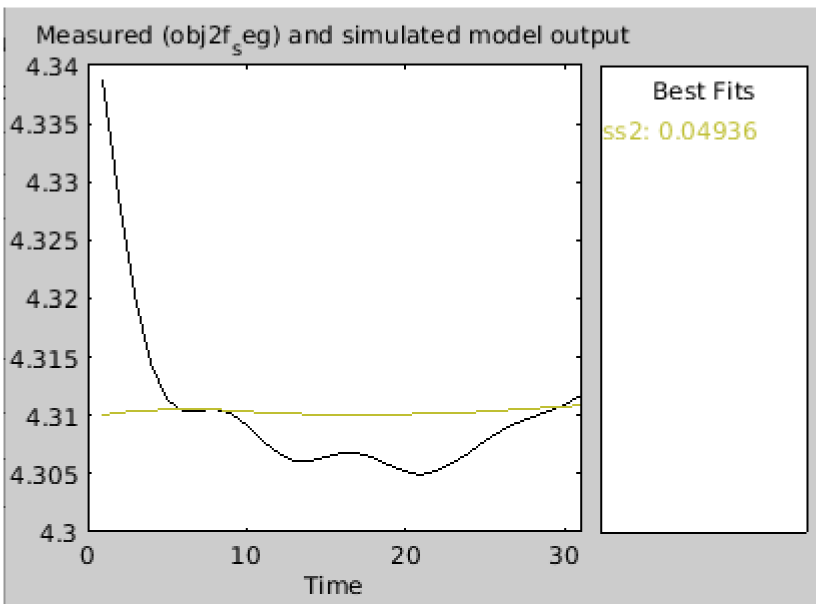
M,C,G terms looks fine since the exp is only elongation motion (G2 = 0.5m0*g = 1.436)

But when using 0th-order state space model:



The results are similar even we increase the order of the state space model or increase the input delay for pneumatic input u_1

We also tried only using the steady-state data



My current guesses:

1. Sensor noise significantly affects the sysid results.
2. Unmodeled dynamics cannot be ignored (friction, pneuamtic dyn.)