Spindown Test and Turntable Friction Modeling

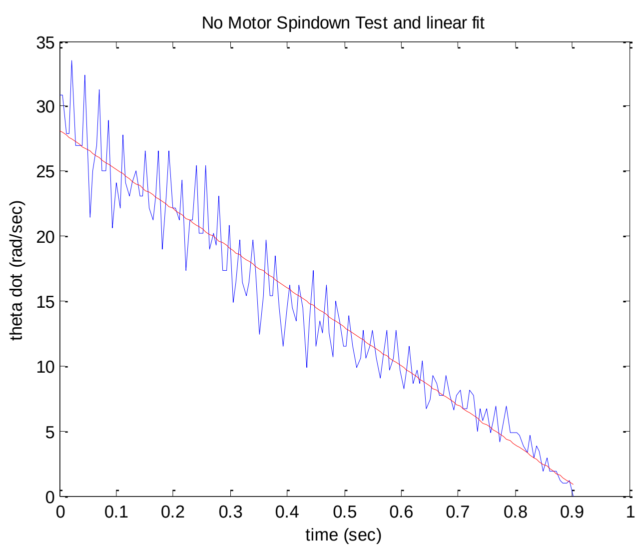
UCSD MAE156a

Parameters you will need: Inertia of turntable: **8.84e-4 Kgm2** Inertia of Motor Armature: **4.97e-7 Kgm2**

To evaluate and model friction in a system under dynamic conditions we can perform a spindown test whereby we bring the system to a terminal velocity, then shut off power and allow it to spin down to a stop while recording its position and velocity. During a spindown test the only torque applied to the turntable is the friction torque, τ_f. Accordingly:

$$\tau_f = I\ddot{\theta}$$

Calculating the acceleration of the turntable is often noisy due to the double derivative it requires. In the case of the turntable example below, the velocity vs. time relationship is linear. A straight slope indicates constant acceleration that is not speed dependent, therefore Coulomb friction is dominant and viscous friction is negligible. The acceleration is slope of the velocity, which can be determined by a least squares fit.



The friction can be represented in the turntable coordinates, and corresponds to the amount of torque required to apply to the turntable to overcome friction, which is designated as $\tau_{tt,f}$. Alternatively, the friction can be represented in the drive-wheel coordinates, and corresponds to the amount of torque required to apply to the drive-wheel to overcome friction, which is designated as $\tau_{dw,f}$. Using the results of the dynamics assignment, we see that both following equations are valid:

$$\tau_{\mathrm{tt,f}} = I_{\mathrm{eq,tt}}\ddot{\theta}_{tt}$$

$$\tau_{\mathrm{dw,f}} = I_{\mathrm{eq,dw}}\ddot{\theta}_{\mathrm{dw}}$$

Choose one coordinate system, and calculate the friction torque using the measured deceleration. Make sure to use the proper equivalent inertia.