Outline notes on Friction
please see class lecture notes for the details and references!

The Dahl and LuGre Model

Dahl Friction model

$$\frac{dF}{dx} = \sigma_0 \left(1 - \frac{F}{Fv} sign(v)\right)$$

On integration this becomes

$$F = F_c(1 - e^{-\sigma_0 |x|/Fc}) sign(v)$$

Lugre Friction Model. The State equations are

$$\dot{z} = v - h(v)z$$

$$F = \sigma_0 z + \sigma_1 \dot{z} + f(v)$$

where $h(v) = \sigma_0 \frac{|v|}{g(v)}$

Typically $f(v)$ would be viscous friction, i.e.$f(v) = \sigma_2 v$. A reasonable choice for $g(v)$ that models both coulomb friction and the Stribeck effect is

$$g(v) = F_c + (F_s - F_c)e^{|-v/v_s|^\alpha}$$

The Dahl and LuGre Model

- The Dahl model is a simplified version of the Lugre model
- The Dahl model does not account for the stribeck effect
- The state z, can be considered as a bristle deflection
- F_c is the coulomb friction F_s is the limit of static friction
- In the LuGre model typical values are $0.5 < \alpha < 2$