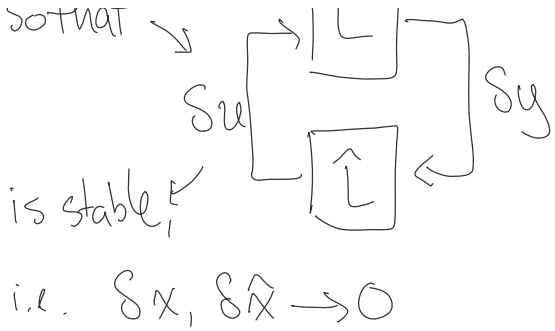
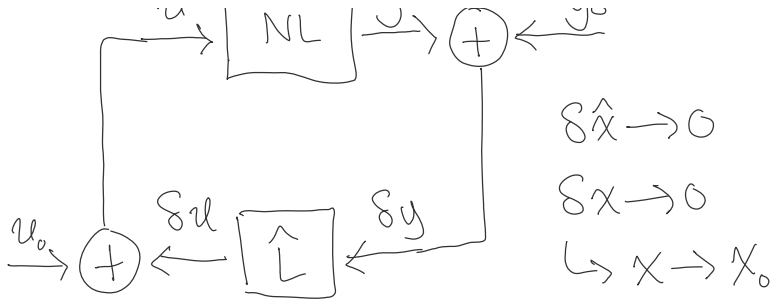
goal: apply full-state observer + controller to nonlinear system using linearization

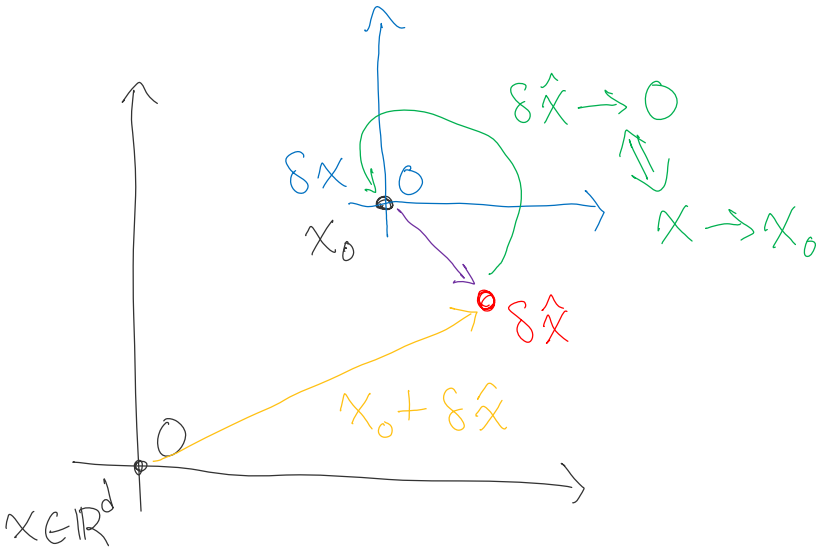
refs: Hespanha 2009 Ch 2
Astrom & Murray 2019 Ch 6

- suppose given NL $\begin{cases} \dot{x} = f(x,u) \\ y = h(x,u) \end{cases}$ with operating point / equilibrium (x_0, u_0) s.t. $f(x_0,u_0)=0$
  (let $y_0 = h(x_0,u_0)$)
- linearize to obtain L $\begin{cases} \delta\dot{x} = A\,\delta x + B\,\delta u \\ \delta y = C\,\delta x + D\,\delta u \end{cases}$ where: $x \simeq x_0 + \delta x$, $u \simeq u_0 + \delta u$, $y \simeq y_0 + \delta y$
- synthesize full-state observer + controller for L $\begin{cases} \delta\dot{\hat{x}} = A\,\delta\hat{x} + B\,\delta u - L(\delta\hat{y} - \delta y) \\ \delta\hat{y} = C\,\delta\hat{x} + D\,\delta u, \quad \delta u = -K\,\delta\hat{x} \end{cases}$

so that


SOTHAT
L
δu
δy
$\hat{L}$
is stable,
i.e. $\delta x, \delta\hat{x} \to 0$


NL
u_0
δu
δy
$\hat{L}$
$\delta\hat{x} \to 0$
$\delta x \to 0$
$\hookrightarrow x \to x_0$


$\delta\hat{x} \to 0$
δx
x_0
$x \to x_0$
$\delta\hat{x}$
$x_0 + \delta\hat{x}$
0
$x \in \mathbb{R}^d$