Bryan Ngo

Stability

Feedback

Least Square

EECS 16B CSM

Bryan Ngo

UC Berkeley

2020-10-25



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Feedback

Least Squares

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Continuous

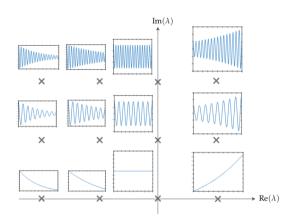
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Discrete

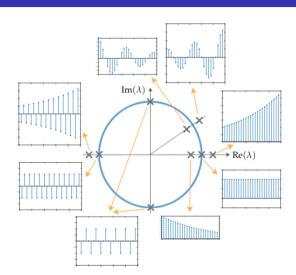
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Open-Loop

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$$x[t+1] = Ax[t] + Bu[t]$$
(1)

- define a certain range of use
- simpler
- no restraints apart from stability

Closed-Loop

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$$\boldsymbol{u}[t] = \begin{bmatrix} k_1 & k_2 & \cdots & k_n \end{bmatrix} \begin{bmatrix} x_1[t] \\ x_2[t] \\ \vdots \\ x_n[t] \end{bmatrix}$$

$$(2)$$

$$x[t+1] = Ax[t] + BKx[t] = (A+BK)x[t]$$
(3)

- adaptable to a wide range of use
- more complex
- self-correcting
- requires more constraints



Controller Canonical Form

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$$\boldsymbol{x}[t+1] = \begin{bmatrix} 0 & 1 & 0 & \cdots & 0 \\ 0 & 0 & 1 & \cdots & 0 \\ \vdots & \vdots & \vdots & \ddots & \vdots \\ 0 & 0 & 0 & \cdots & 1 \\ a_1 & a_2 & a_3 & \cdots & a_n \end{bmatrix} \boldsymbol{x}[t] + \begin{bmatrix} 0 \\ 0 \\ 0 \\ \vdots \\ 1 \end{bmatrix} \boldsymbol{u}[t]$$
(4)

$$\det(\mathbf{A} + \mathbf{B}\mathbf{K} - \lambda \mathbf{I}) = \lambda^n - \sum_{i=1}^n (a_i + k_i)\lambda^i$$
(5)

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Quick Review

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$$\mathbf{A}\mathbf{x} = \mathbf{b} \implies \hat{\mathbf{x}} \approx ([\mathbf{A}]^{\mathsf{T}}\mathbf{A})^{-1} [\mathbf{A}]^{\mathsf{T}}\mathbf{b}$$
 (6)

lacksquare we want to minimize the error vector $e=b-A\hat{x}$