ELL333

MULTIVARIABLE CONTROL

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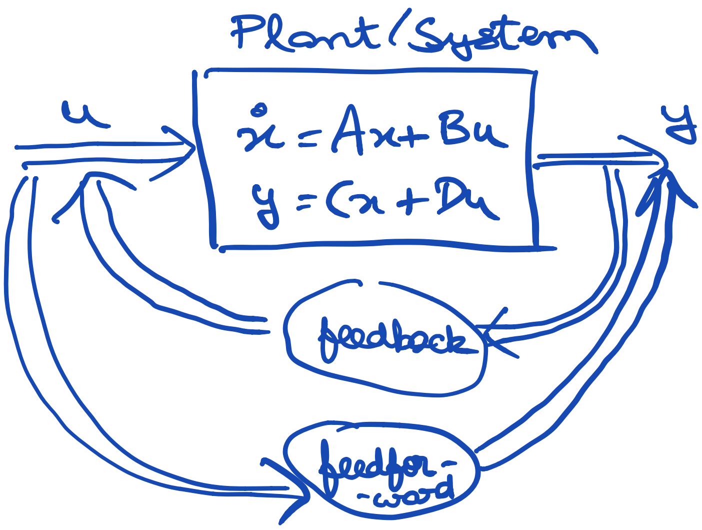
Design Specifications, typical

Especially for first two, we want to change the eigenvalues to desired locations

- Stability
- Transient response
- Noise reduction
- parameter uncertainty robustness



Control strategies

- Feedback: input is made a function of output.
- Feedforward: anticipatory action is added to input.

  (D is feedforward term)

Focus is on feedback

Therefore, we set $D = 0$.

System: $\dot{x} = Ax + Bu$

$y = Cx$

To make input a function of output

- $u = -Ky$, K is a constant
- $u = -\underbrace{K(s)}\, y$, this is in Laplace domain and indicates some y-dynamics

$\boxed{\text{GAP}}$: While this is natural, <u>most</u> treatments start with $u = -Kx$.

state

Most common justification:

Output is a function of state.

State has more information about the system then the output, so we start with a state.

Note the gap, and start with

$$u = \underbrace{-Kx}_{\text{state feedback}} + \underbrace{k_r r}_{\text{reference input}}$$

To see whether eigenvalues can be changed,

$$\dot{x} = Ax + Bu$$

$$\Rightarrow \dot{x} = Ax + B(-Kx + k_r r)$$

$$\Rightarrow \dot{x} = (A - BK)x + Bk_r r$$

- How to move eigenvalues of $(A - BK)$ to desired locations, as it is these eigenvalues which determine properties like stability, transient response etc.?
- Can this be done? Controllability Test
- A Controllable canonical form helps this exercise.
- Part of the concept of controllability

  reachability (used in the textbook)

State feedback, $u = -Kx + k_r r$ uses 'x'.

Where to get the x?

We get x, from output y, because that is, by definition what we measure.

if $y = x$, then easy problem.

if not, then more work has to be done ...

$\boxed{\text{GAP}}$: In some sense, we want to $\boxed{\text{extract/filter}}$ information of x from y.

Observer, related to Kalman Filter

$$\dot{\hat{x}} = A\hat{x} + Bu + L(y - \hat{y})$$
$$\hat{y} = C\hat{x}$$

This is a filter (?), with the aim of reconstructing the state. We would like $\hat{x}$ to be equal to x.