ME 343 – Control Systems

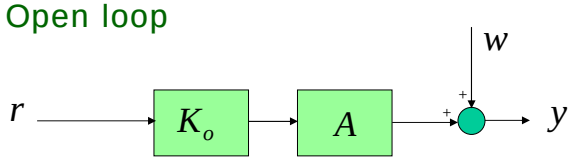
Lecture 10

September 14, 2009

Properties of Feedback

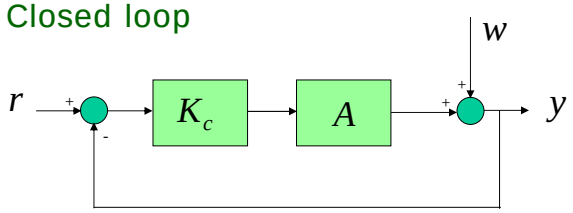
Disturbance Rejection:

Open loop



$$y = K_o A r + w$$

Closed loop



$$y = \frac{K_c A}{1 + K_c A} r + \frac{1}{1 + K_c A} w$$

Properties of Feedback

Disturbance Rejection:

Choose control s.t. for $w=0, y \approx r$

Open loop: $K_o = \frac{1}{A} \Rightarrow y = r + w$

Closed loop: $K_c >> \frac{1}{A} \Rightarrow y \approx r + 0w = r$

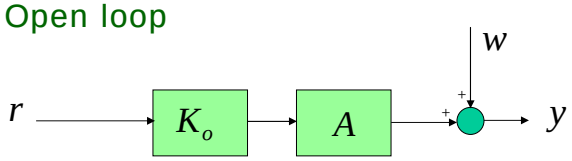
Feedback allows attenuation of disturbance without having access to it (without measuring it)!!!

IMPORTANT: High gain is dangerous for dynamic response!!!

Properties of Feedback

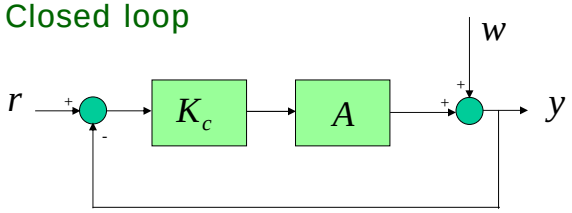
Sensitivity to Gain Plant Changes

Open loop



$$T_o = \left(\frac{y}{r}\right)_o = AK_o$$

Closed loop



$$T_c = \left(\frac{y}{r}\right)_c = \frac{AK_c}{1+AK_c}$$

Properties of Feedback

Sensitivity to Gain Plant Changes

Let the plant gain be $A+\delta A$

Open loop: $\dfrac{\delta T_o}{T_o}=\dfrac{\delta A}{A}$

Closed loop: $\dfrac{\delta T_c}{T_c}=\dfrac{\delta A}{A}\dfrac{1}{1+AK_c}<<\dfrac{\delta A}{A}=\dfrac{\delta T_o}{T_o}$

Feedback reduces sensitivity to plant variations!!!

Sensitivity: $S_A^T=\dfrac{dT/T}{dA/A}=\dfrac{A}{T}\dfrac{dT}{dA}$

Example: $S_A^{T_c}=\dfrac{1}{1+AK_c}, S_A^{T_o}=1$

Properties of Feedback

Example: FPE 4.3