Effetto della retroazione sulla reiezione dei disturbi

Contents map

developed content units	taxonomy levels
reiezione dei disturbi	u1, e1

prerequisite content units	taxonomy levels
funzione di trasferimento	u1, e1
controllo in catena chiusa	u1, e1

Roadmap

- definizioni
- esempi importanti

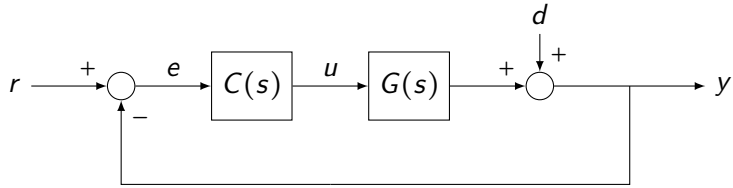
Cosa impariamo ora?

definizione: reiettare i disturbi = attenuarli.

Cosa impariamo ora?

definizione: reiettare i disturbi = attenuarli. Rispondere alla domanda: la retroazione migliora le caratteristiche di reiezione ai disturbi?

Strumento per rispondere alla domanda = FdT

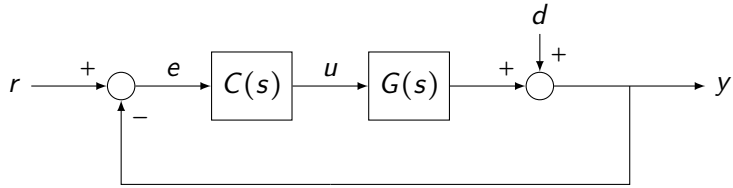


$$Y(s) = Y_r(s) + Y_d(s) = W_{ry}(s)R(s) + W_{dy}(s)D(s)$$

$$W_{dy}(s) = \frac{1}{1 + C(s)G(s)}$$

per avere $Y_d(s)$ "piccolo" serve avere $W_{dy}(s)$ "piccolo" e quindi $C(s)$ "grande"

FdT significa anche "risposta in frequenza"



$$W_{dy}(s) = \frac{1}{1 + C(s)H(s)G(s)}$$

implica che se $d(t) = \cos(\omega t)$ allora l'andamento a regime di $y_d(t)$ sara'

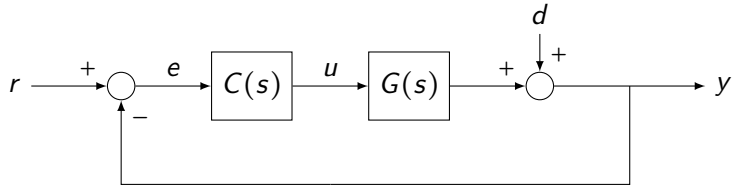
$$y_d(t) \simeq \left|W_{dy}(j\omega)\right| \cos\left(\omega t + \angle W_{dy}(j\omega)\right)$$

e quindi vogliamo $C(s)$ "grande"

Vogliamo sempre $C(s)$ "grande"?

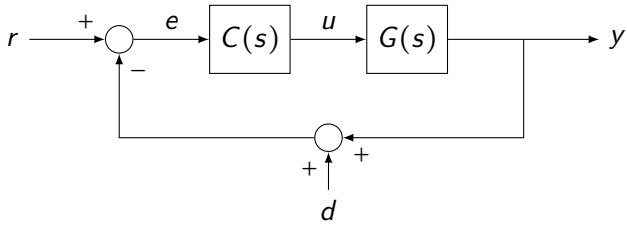
NO: dipende da dove entrano i disturbi!

Esempio dove vogliamo $C(s)$ "grande"



$$W_{dy}(s) = \frac{1}{1 + C(s)G(s)}$$

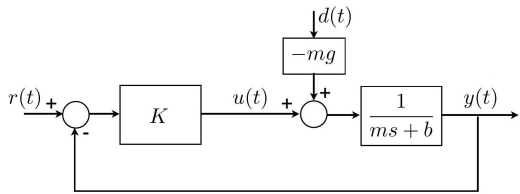
Esempio dove vogliamo $C(s)$ "piccolo"



$$W_{dy}(s) = \frac{-C(s)G(s)}{1 + C(s)G(s)}$$

$\Longrightarrow$ $C(s)$ e' al numeratore e al denominatore, quindi per avere $\left|W_{dy}(j\omega)\right|$ piccolo serve $C(j\omega)$ piccolo

Esempio: controllo della velocita' dell'auto con un P



$$W_{dy}(s) = \frac{-mgG(s)}{1 + C(s)G(s)} = \frac{-mg}{ms + b + K}$$

e quindi $\left|W_{dy}(j\omega)\right| \to 0$ per $K \to +\infty$

Self-assessment

Question 1

In the context of feedback control systems, why is the position where a disturbance enters the system important?

Potential answers:

I: It determines whether the system will be stable or unstable
II: It affects whether we want the controller gain to be large or small for effective rejection
III: It specifies the required sampling frequency for digital control
IV: It defines the physical location where we should place additional sensors
V: I do not know

Question 2

When analyzing disturbance rejection through frequency response, what does it mean to want the controller $C(j\omega)$ "large" at a certain frequency?

Potential answers:

I: The controller should have many state variables at that frequency
II: The physical size of the controller hardware should be large
III: The magnitude $|C(j\omega)|$ should be large compared to other system components
IV: The controller should have a large time delay at that frequency
V: I do not know

Question 3

What is the fundamental advantage of using feedback control for disturbance rejection compared to open-loop control?

Potential answers:

I: Feedback control always requires less energy than open-loop control
II: Feedback control can actively counteract disturbances based on their effect on the output
III: Feedback control eliminates the need for accurate system modeling
IV: Feedback control works for any type of disturbance without tuning
V: I do not know

Question 4

Why can't we simply make the controller gain extremely large to achieve perfect disturbance rejection?

Potential answers:

I: Because large gains violate conservation of energy principles
II: Because all real systems are nonlinear at high gains
III: Because high gains may lead to instability or other undesirable dynamics
IV: Because sensor noise would be completely eliminated
V: I do not know

Question 5

For a disturbance entering at the plant output (d-after-G configuration), what happens to the disturbance-to-output transfer function $W_{dy}(s)$ if we make the controller gain very large?

Potential answers:

I: It becomes an integrator
II: Its magnitude at most frequencies becomes very small
III: It becomes exactly 1 at all frequencies
IV: It becomes unstable
V: I do not know

Recap of the module “Effetto della retroazione sulla reiezione dei disturbi”

- a seconda di dove introduco i disturbi i casi sono diversi
- a volte serve un controllore "grande" a volte "piccolo"