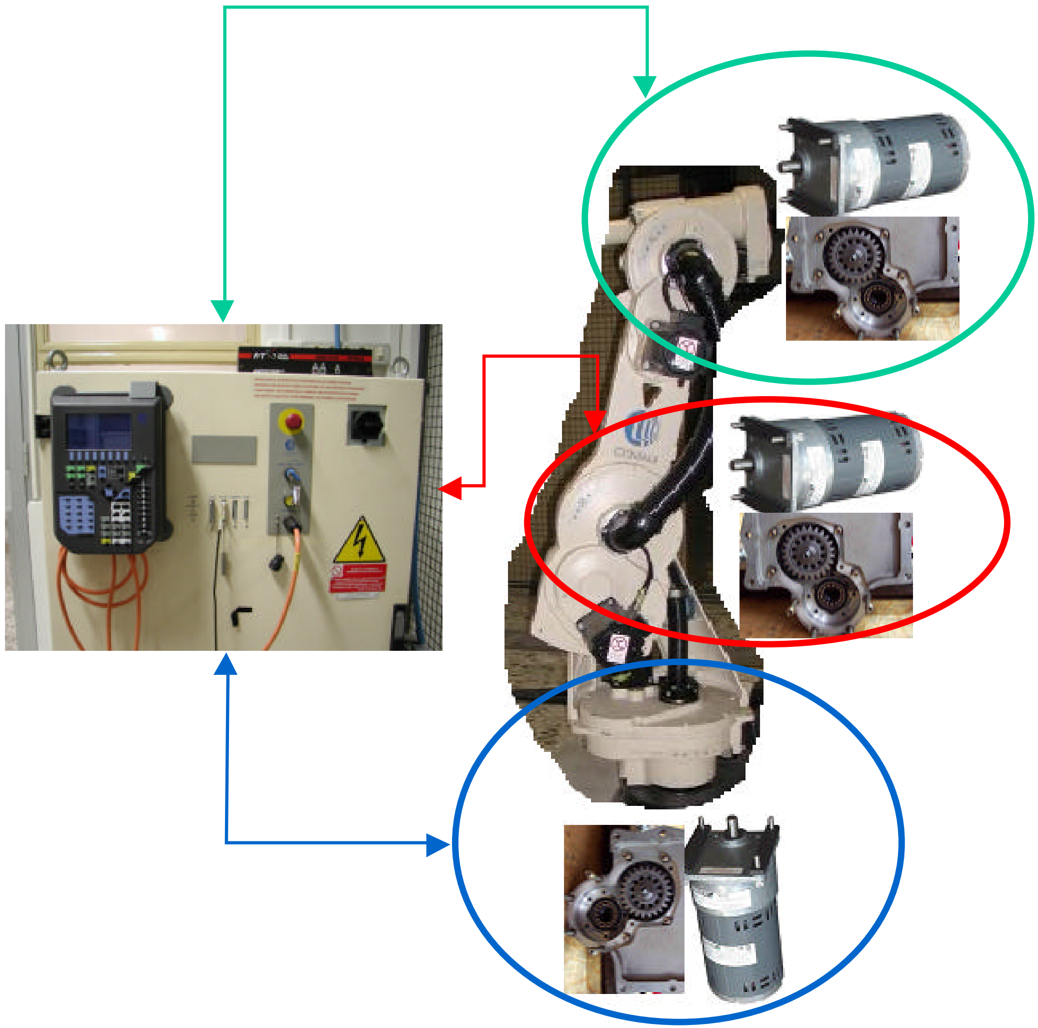


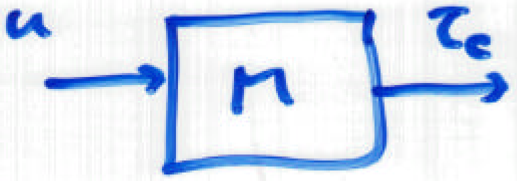
CONTROLLO DEI ROBOT
(BRACCI MANIPOLATORI)

- ROBOT = EQUAZIONE

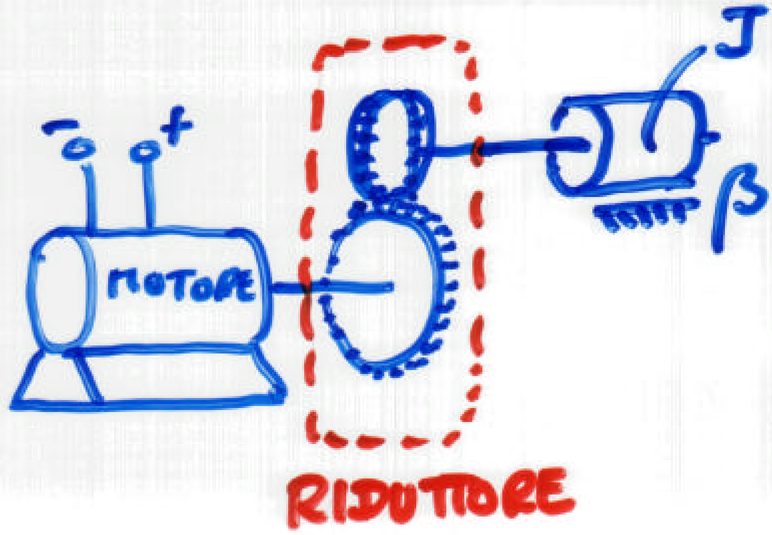
$$H(q)\ddot{q} + C(q,\dot{q})\dot{q} + g(q) = \tau_c$$

COPPIE DI COMANDO

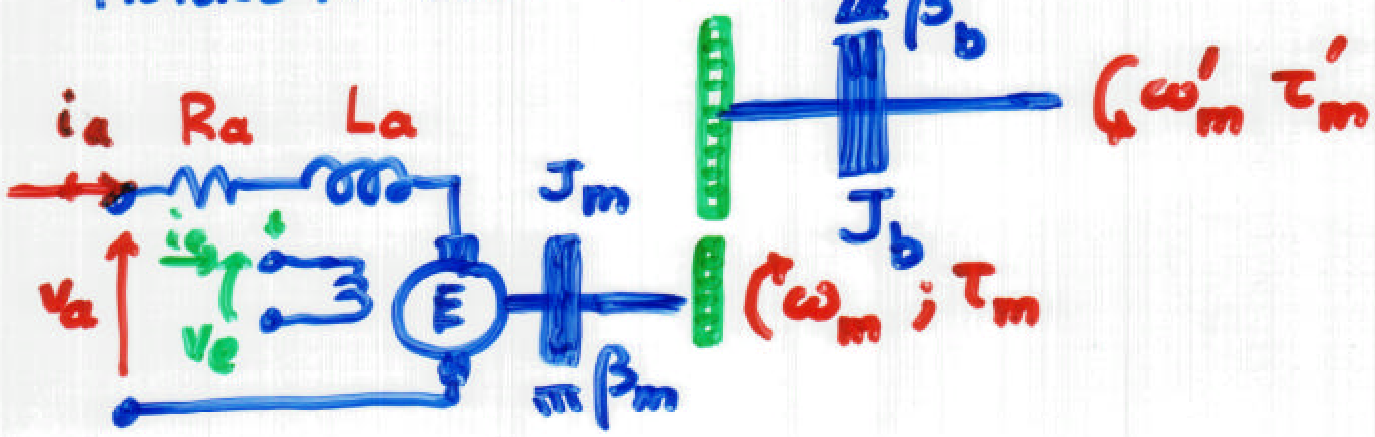
τ_c SONO GENERATE DA MOTORI



MODELLISTICA MOTORE + RIDUTTORE
GEAR BOX



MOTORE A C.C. : MODELLO DINAMICO



$\Phi = K_\phi i_e$ se $i_e = \text{cost}$; $\Phi = \text{cost}$

forza contro elettro motrice

$$v_a = R_a i_a + L_a \frac{d i_a}{dt} + E$$

$$\frac{d}{dt} i_a = \left[v_a - R_a i_a - E \right] \frac{1}{L_a}$$

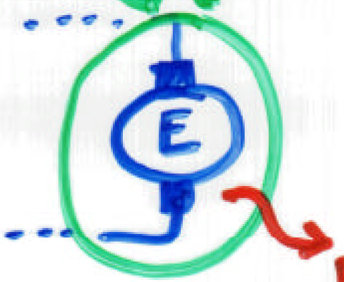
$$\boxed{\dot{x} = -\frac{R_a}{L_a} x + u} \qquad u = \frac{1}{L_a}(v_a - E)$$

DINAMICA ELETTRICA

$$E = k\phi\,\omega_m = \boxed{K_\omega\,\omega_m} \qquad K_\omega = k\phi$$

Costante

$$P_e = E\,i_a$$



$$P_m = \tau_m\,\omega_m$$

IPOTESI

$$P_e = P_m \quad \text{rendimento } 1$$

$$E = \frac{\tau_m}{i_a}\,\omega_m$$

$$\tau_m = k'\phi\,i_a = K_\tau\,i_a$$

$$\boxed{E = K_\tau\,\omega_m}$$

NELL'IPOTESI DI RENDIMENTO TRASF. ELETTROMECC. $= 1$

$$K_\tau = K_\omega \Rightarrow k = k'$$

$$E\,i_a \simeq \tau_m\,\omega_m$$

LA DIFFERENZA % TRA k e k' E' $1 \cdot 10^{-4}$

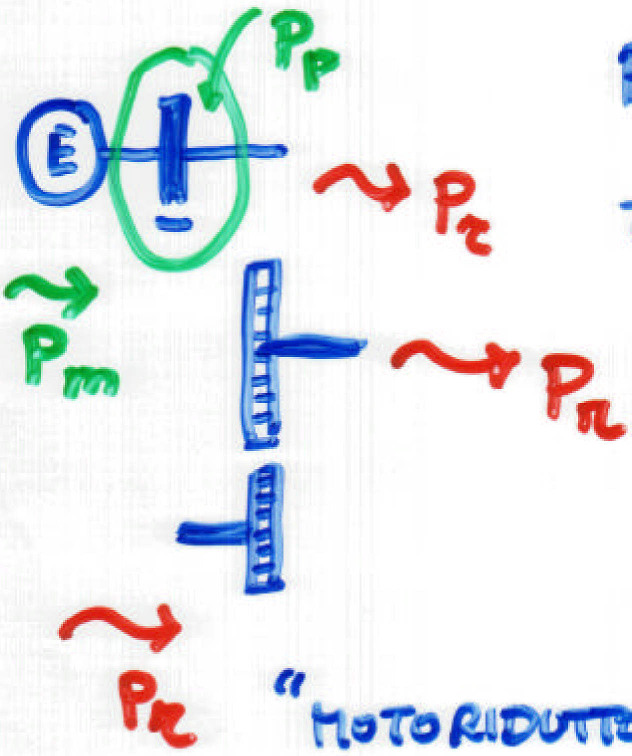
$$\tau_p = \text{COPPIA PERSA} = J_m \dot{\omega}_m + \beta_m \omega_m$$

$$= J_m \ddot{\theta}_m + \beta_m \dot{\theta}_m$$

θ_m = ANGOLO MOTORE

$\dot{\theta}_m = \omega_m$ = VEL. MOTORE

$\ddot{\theta}_m = \dot{\omega}_m$ = ACCEL. "



$$P = \omega \tau$$

$$\tau_r = \tau_m - \tau_p$$

"MOTORIDUTTORE IDEALE"

$$P_{r\,entrante} = P_{r\,uscente}$$

$$\tau_r \omega_m = \tau'_r \omega'_m$$

$$\frac{\omega_m}{\omega'_m} = \frac{\tau'_r}{\tau_r}$$

IN ROBOTICA I MOTORIDUTTORI SERVONO A RIDURRE LA VELOCITA' E AD AUMENTARE LA COPPIA

LATO BRACCIO

LATO MOTORE

$$\frac{\rho'}{\rho} = \frac{N'}{N} > 1 = r$$

$1 \div 100$

$1:100$

$1:50 \div 1:150$

$\rightarrow 50 \leq r \leq 150,$

$$\boxed{\omega_m = r\,\omega'_m}$$

$$\boxed{\tau'_r = r\,\tau_r}$$

$$\tau_r \omega_m = \cancel{r}\,\omega'_m \frac{\tau'_m}{\cancel{r}} = \omega'_m \tau'_m$$

$$\tau'_r - \tau'_p = \tau'_m$$

$$\tau'_p = J_b \dot{\omega}'_m + \beta_b \omega'_m$$

$$r\ddot{\theta}'_m \qquad r\dot{\theta}'_m$$

$$\tau'_r = r\tau_r = r(\tau_m - \tau_p)$$

$$= r(\tau_m - J_m \ddot{\theta}_m - \beta_m \dot{\theta}_m)$$

$$= r\tau_m - r^2 (J_m \dot{\omega}'_m + \beta_m \omega'_m)$$

ESPRESSIONE "<u>COERENTE</u>": USA SOLO VARIABILI A VALLE MOTORIDUTTORE

$r = 100 \qquad r^2 = 10000$

L'INERZIA DEL BRACCIO VISTA AL PRIMARIO È <u>DIVISA</u> PER r^2 $\qquad \frac{1}{r^2}$

FORZE CONTATTO

$$\underline{\tau} = H\underline{\ddot{q}} + C(\underline{q},\underline{\dot{q}})\underline{\dot{q}} + \underline{g}(\underline{q}) + J^T \underline{F_e} +$$

$$+ \underbrace{B\dot{q}}_{\text{ATTRITO}}$$

i-esima equazione :

$$\tau'_{r,i} = \sum_j^n H_{ij}\ddot{q}_j + \sum\sum h_{ijk}\dot{q}_j\dot{q}_k + g_i$$

$$+ \beta_{bi}\dot{q}_i + \tau'_{F,i}$$

PAG. 7-9

a monte

$$= J_{b,i}\frac{\ddot{\theta}_m}{r_i} + \beta_{b,i}\frac{\dot{\theta}_m}{r} + \tau'_{M,i} + \tau'_{C,i} +$$

$$+ \tau'_{g,i} + \tau'_{F,i}$$

PAG. 10

$$\tau'_{r,i} = J_{bi}\frac{\ddot{\theta}_m}{r_i} + \beta_{b,i}\frac{\dot{\theta}_m}{r_i} + \text{altro}\ \tau'_{d,i}$$

disturbo

"CONTROLLO DI MANIPOLATORI INDUSTRIALI" CHE POTETE SCARICARE DAL SOLITO SITO

$$\tau'_{r,i} = \frac{1}{r_i}\left[J_{bi}\,\ddot{\theta}_m + \beta_{bi}\,\dot{\theta}_m\right] + \tau'_{d,i}$$

VEDE "A VALLE"

$$\tau'_{r,i} = r_i\tau_{r,i} = r_i\tau_{mi} - r_i^2\left(J_{mi}\,\dot{\omega}'_{mi} + \beta_{mi}\,\omega'_{mi}\right)$$

VEDE "A MONTE"

PORTARE "A MONTE" SUI MOTORI

TOGLIERE PEDICE i

$$\tau_m = \tau_r + \tau_p$$

$$\tau_r = \frac{1}{r}\tau'_r = \frac{1}{r^2}\left(J_b\,\ddot{\theta}_m + \beta_b\,\dot{\theta}_m\right) + \frac{1}{r}\tau'_d$$

$$\tau_m = \underbrace{\left[\frac{1}{r^2}J_b + J_m\right]}_{J_t}\ddot{\theta}_m + \underbrace{\left[\frac{1}{r^2}\beta_b + \beta_m\right]}_{\beta_t}\dot{\theta}_m + \frac{1}{r}\tau'_d$$

$$J_t = \frac{1}{r^2} J_b(\underline{q}) + J_m$$

$$\beta_t = \frac{1}{r^2}\beta_b + \beta_m$$

$$\tau_d = \frac{1}{r}\tau'_d$$

$$\boxed{\tau_m - \tau_d = J_t \ddot{\theta}_m + \beta_t \dot{\theta}_m} \quad **$$

$J_t = J_t(\underline{q})$ ma dove la configurazione conta poco $\cdots \frac{1}{r^2}$

usiamo ** per il controllo