Manipolatore di Stanford

$$\tau = K_p e + K_d \dot{e} + G(q) \tag{1}$$

$$K_p = \begin{bmatrix} 1000 & 0 & 0 & 0 & 0 & 0 \\ 0 & 1000 & 0 & 0 & 0 & 0 \\ 0 & 0 & 100 & 0 & 0 & 0 \\ 0 & 0 & 0 & 100 & 0 & 0 \\ 0 & 0 & 0 & 0 & 100 & 0 \\ 0 & 0 & 0 & 0 & 0 & 10 \end{bmatrix} \tag{2}$$

$$K_d = \begin{bmatrix} 10 & 0 & 0 & 0 & 0 & 0 \\ 0 & 100 & 0 & 0 & 0 & 0 \\ 0 & 0 & 10 & 0 & 0 & 0 \\ 0 & 0 & 0 & 10 & 0 & 0 \\ 0 & 0 & 0 & 0 & 10 & 0 \\ 0 & 0 & 0 & 0 & 0 & 10 \end{bmatrix} \tag{3}$$

$$\tau = B(q)[\ddot{q}_d + K_p e + K_d \dot{e}] + C(q,\dot{q})\dot{q} + G(q) \tag{4}$$

$$K_p = \begin{bmatrix} 1 & 0 & 0 & 0 & 0 & 0 \\ 0 & 1 & 0 & 0 & 0 & 0 \\ 0 & 0 & 1 & 0 & 0 & 0 \\ 0 & 0 & 0 & 1 & 0 & 0 \\ 0 & 0 & 0 & 0 & 1 & 0 \\ 0 & 0 & 0 & 0 & 0 & 1 \end{bmatrix} \tag{5}$$

$$K_d = \begin{bmatrix} 1 & 0 & 0 & 0 & 0 & 0 \\ 0 & 1 & 0 & 0 & 0 & 0 \\ 0 & 0 & 1 & 0 & 0 & 0 \\ 0 & 0 & 0 & 1 & 0 & 0 \\ 0 & 0 & 0 & 0 & 1 & 0 \\ 0 & 0 & 0 & 0 & 0 & 1 \end{bmatrix} \tag{6}$$

$$\tau = Y\hat{\pi} + K_d \dot{e} + K_p e \tag{7}$$

$$u_\pi = R^{-1} Y^T M^{-T} B^T P x \tag{8}$$

$$K_p = \begin{bmatrix} 1000 & 00 & 0 & 0 & 0 & 0 \\ 0 & 10000 & 0 & 0 & 0 & 0 \\ 0 & 0 & 1000 & 0 & 0 & 0 \\ 0 & 0 & 0 & 1000 & 0 & 0 \\ 0 & 0 & 0 & 0 & 1000 & 0 \\ 0 & 0 & 0 & 0 & 0 & 10 \end{bmatrix} \tag{9}$$

$$K_d = \begin{bmatrix} 100 & 00 & 0 & 0 & 0 & 0 \\ 0 & 1000 & 0 & 0 & 0 & 0 \\ 0 & 0 & 1000 & 0 & 0 & 0 \\ 0 & 0 & 0 & 100 & 0 & 0 \\ 0 & 0 & 0 & 0 & 100 & 0 \\ 0 & 0 & 0 & 0 & 0 & 10 \end{bmatrix} \tag{10}$$

$$R = I_6 \tag{11}$$

$$A = \begin{bmatrix} 0_6 & I_6 \\ -K_p & -K_d \end{bmatrix} \tag{12}$$

$$B = \begin{bmatrix} 0_6 \\ I_6 \end{bmatrix} \tag{13}$$

$$Q = I_{12} \tag{14}$$

$$A^T P + PA = -Q \tag{15}$$

Granty crane

$$\ddot{\theta}D + [\ddot{x}lcos\theta + glsin\theta]B = -b_1\dot{\theta} \tag{16}$$

$$\ddot{x}C + [\ddot{x}lcos\theta + glsin\theta]B = F - b_2\dot{x} \tag{17}$$

$$B = m_1 + \frac{1}{3}m_2 \tag{18}$$

$$C = m_1 + m_2 + M \tag{19}$$

$$D = \frac{2}{5}m_1 r^2 \tag{20}$$

$$\mathbf{q} = \begin{bmatrix} \theta \\ \dot{\theta} \\ x \\ \dot{x} \end{bmatrix} \tag{21}$$

$$\begin{cases} \dot{q}_0 = q_1 \\ \dot{q}_1 = \frac{-b_1 q_1}{D} - \frac{glsin(q_0)B}{D} + \frac{(b_2 q_3 + glsin(q_0)B)(lcos(q_0)B)}{(C + lcos(q_0)B)D} - \frac{Flcos(q_0)B}{(C + lcos(q_0)B)D} \\ \dot{q}_2 = q_3 \\ \dot{q}_3 = \frac{(-b_2 q_3 - glsin(q_0)B)}{C + lcos(q_0)B} + \frac{F}{C + lcos(q_0)B} \end{cases}$$

$$\dot{q} = f(q) + g(q)u \tag{22}$$

$$y = h(q) \tag{23}$$

$$\mathbf{f(q)} = \begin{bmatrix} q_1 \\ \frac{-b_1 q_1}{D} - \frac{glsin(q_0)B}{D} + \frac{(b_2 q_3 + glsin(q_0)B)(lcos(q_0)B)}{(C + lcos(q_0)B)D} \\ q_3 \\ \frac{(-b_2 q_3 - glsin(q_0)B)}{C + lcos(q_0)B} \end{bmatrix} \tag{24}$$

$$\mathbf{g(q)} = \begin{bmatrix} 0 \\ -\frac{Flcos(q_0)B}{(C + lcos(q_0)B)D} \\ 0 \\ \frac{F}{C + lcos(q_0)B} \end{bmatrix} \tag{25}$$

$$\mathbf{h(q)} = \begin{bmatrix} q_0 \\ q_2 \end{bmatrix} \tag{26}$$

$$\mathbf{z} = \begin{bmatrix} y_0 \\ L_f h_0 \\ y_1 \\ L_f h_1 \end{bmatrix} \tag{27}$$

$$\dot{\mathbf{z}} = \begin{bmatrix} L_f h_0 \\ L_f^2 h_0 + L_g L_f h_0 F \\ L_f h_1 \\ L_f^2 h_1 + L_g L_f h_1 F \end{bmatrix} \tag{28}$$

$$\mathbf{u} = \begin{bmatrix} \frac{v_0 + L_f^2 h_0}{L_g L_f h_0} \\ \frac{v_1 + L_f^2 h_1}{L_g L_f h_1} \end{bmatrix} \tag{29}$$