CS327A
HW 6

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1. b. $U_c(d) = \begin{cases} \frac{1}{2}\eta\left(\frac{1}{d} - \frac{1}{d_0}\right)^2 & \text{if } d < d_0 \\ 0 & \text{if } d \geq d_0 \end{cases}$

$$\nabla U_c = \frac{\partial U_c}{\partial d} \Rightarrow \nabla U_c = \begin{cases} \eta\left(\frac{1}{d} - \frac{1}{d_0}\right) \cdot -1 \cdot \frac{1}{d^2} = -\eta\left(\frac{1}{d} - \frac{1}{d_0}\right)\frac{1}{d^2} \\ 0 \end{cases}$$

c $\quad \tau_{t/c} = N_{constraint}^T J_{task}^T \cdot F_t^* = J_{t/c}^T F_t$

$$F_t = \Lambda_{t/c} \cdot F^* = \left(J_{t/c} A^{-1} J_{t/c}^T\right)^{-1} \times \left(\ddot{x}_d - k_{px} \times (x - x_d) - k_{vx} \times (\dot{x} - \dot{x}_d)\right) \times$$

$$\Rightarrow \tau_{t/c} = J_{t/c} \times \left(J_{t/c} A^{-1} J_{t/c}^T\right)^{-1} \times \left(\ddot{x}_d - k_{px} \times (x - x_d) - k_{vx} \times (\dot{x} - \dot{x}_d)\right)$$

d $\quad \tau_{p/t/c} = J_{ptc}^T F_p = \left(J_{posture} N_{task} N_{constraint}\right)^T F_{posture}$ (identity matrix)

$$= (N_t N_c)^T \left(\ddot{q}_d - k_{pj} \times (q - q_d) - k_{vj} \times (\dot{q} - \dot{q}_d)\right) \times A$$

$$= (N_t N_c)^T \left(-k_{pj} \times (q - q_d) - k_{vj} \times (\dot{q} - \dot{q}_d)\right) \times A$$

joint space control

e. Implementation has been checked by Wesley during office hour