Absolutely stable model-base force controller

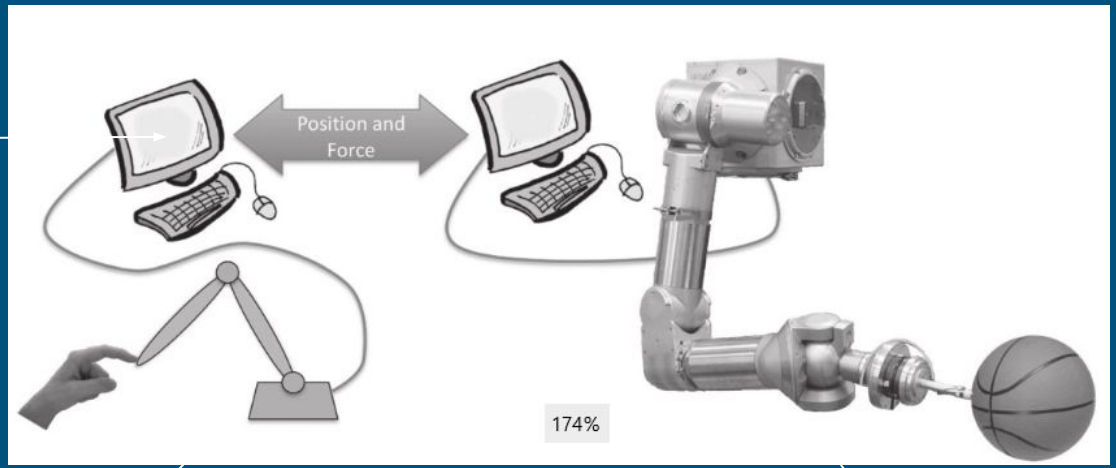
Corso: pHRI

Studente: Giovanni Bagolin, VR445681

Data: 12/10/2020

Intro

Sistema di teleoperazione:



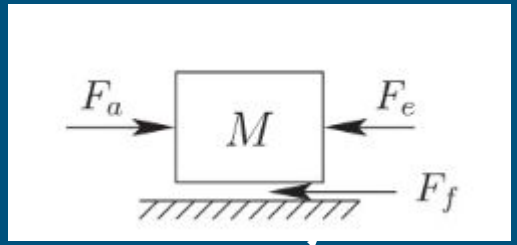
Intro

Robot soggetti a forze:

- inerzia
- attrito
- forze di contatto

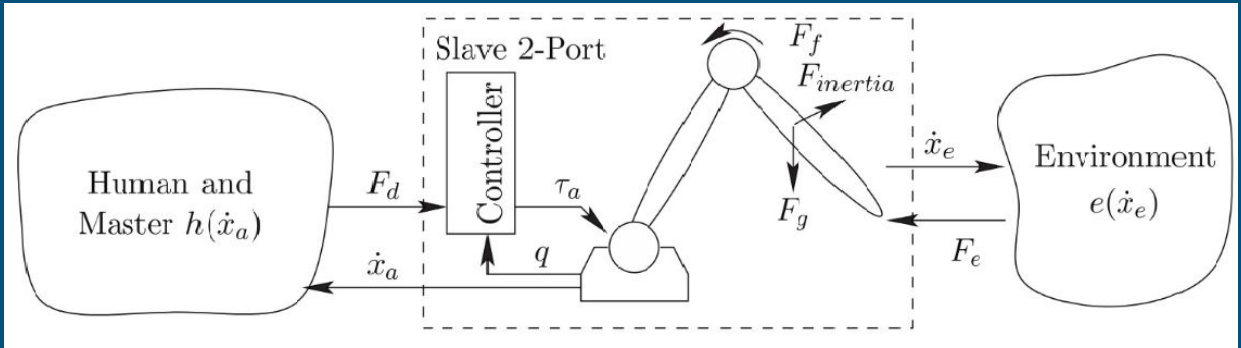
Intro

Obiettivo: ridurre la forza di attrito.



Ff

Controllore di forza basato sul modello ideale



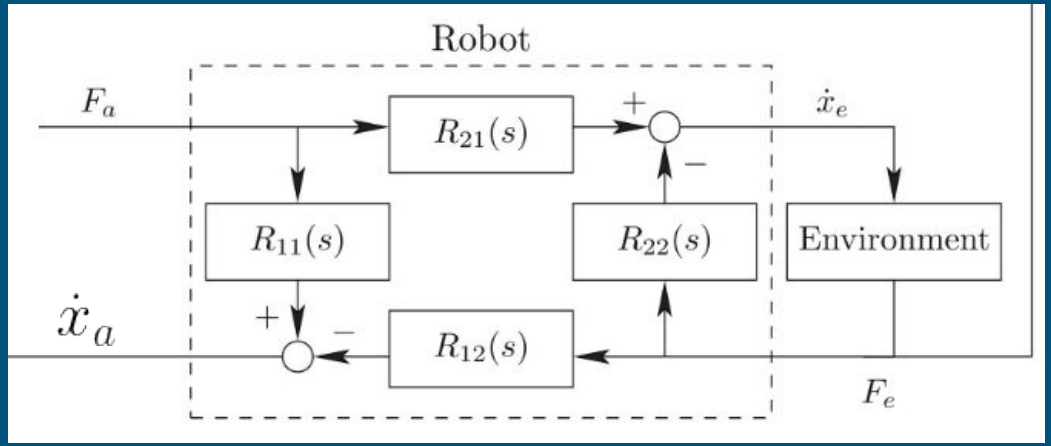
Modello robot slave.

$$F_e = \frac{E(s)}{1 + E(s) \cdot R_{2,2}} \cdot F_d \cdot R_{2,1}$$

$$\dot{x}_e = F_a \cdot R_{2,1} - F_e \cdot R_{2,2}$$

$$\dot{x}_a = F_a \cdot R_{1,1} - F_e \cdot R_{1,2}$$

$$R_{i,j} = \frac{1}{Ms + b}$$



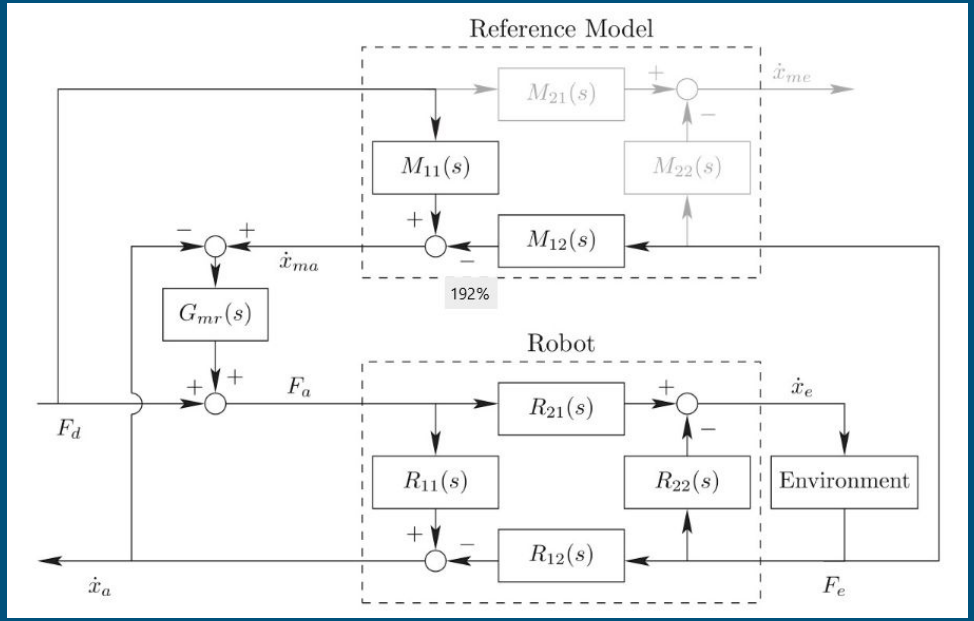
Modello slave + modello ideale

$$M_{i,j} = \frac{1}{M_r s}$$

$$G_{mr}(s) = K$$

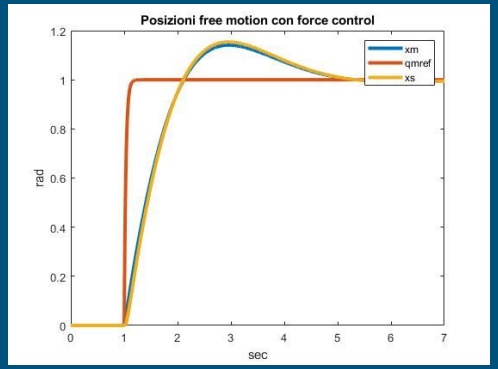
$$\dot{x}_{ma} = F_d \cdot M_{1,1} - F_e \cdot M_{1,2}$$

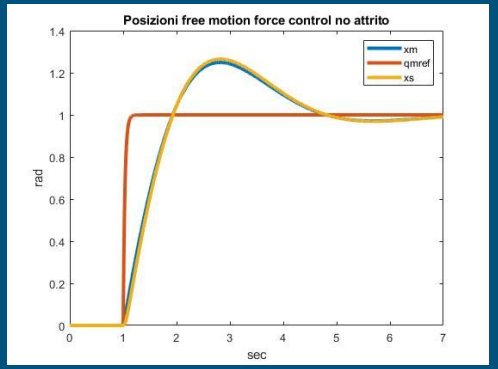
$$F_c = (\dot{x}_{ma} - \dot{x}_a) \cdot G_{mr}(s)$$

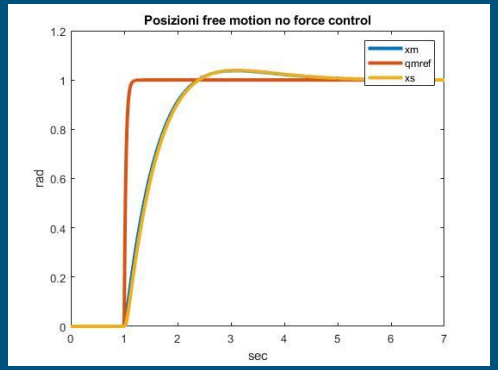


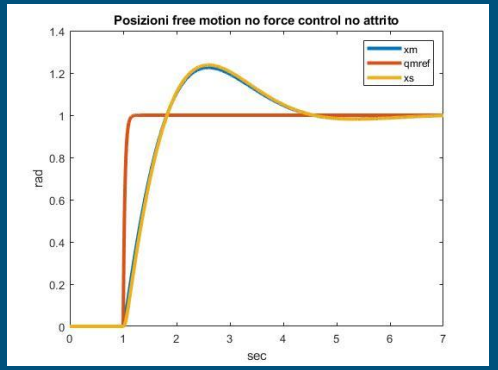
Risultati simulazione

Confronto posizioni



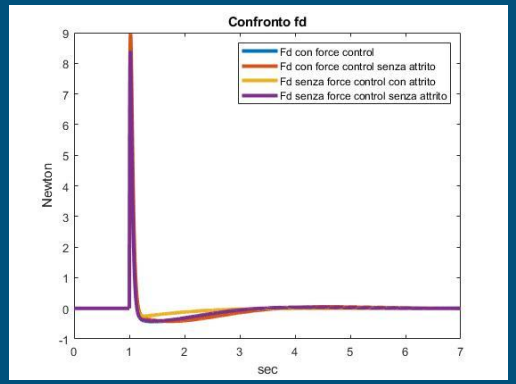


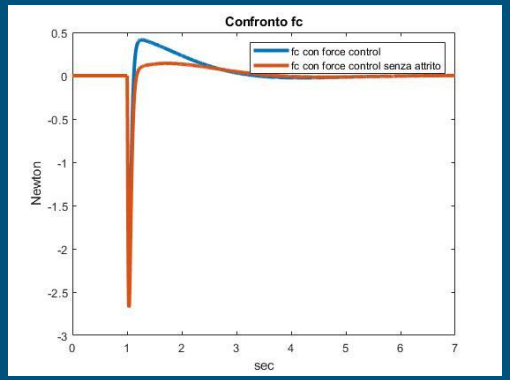


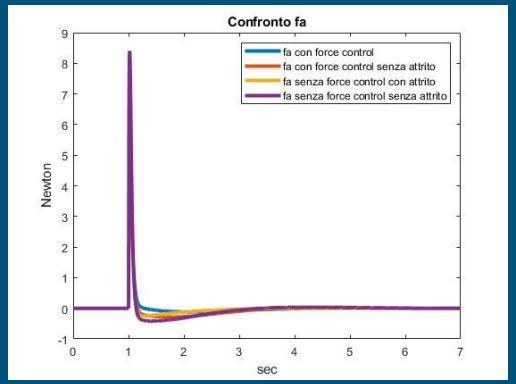


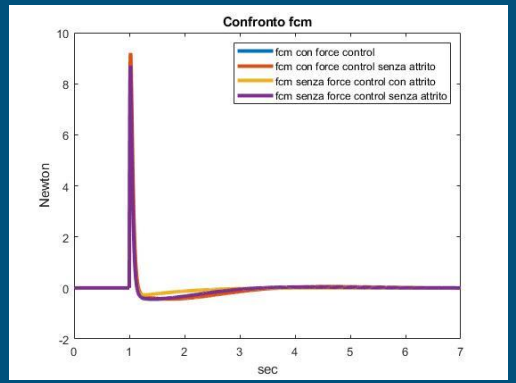
Risultati simulazione

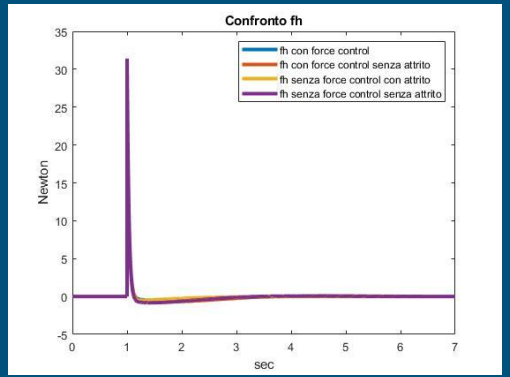
Confronto forze





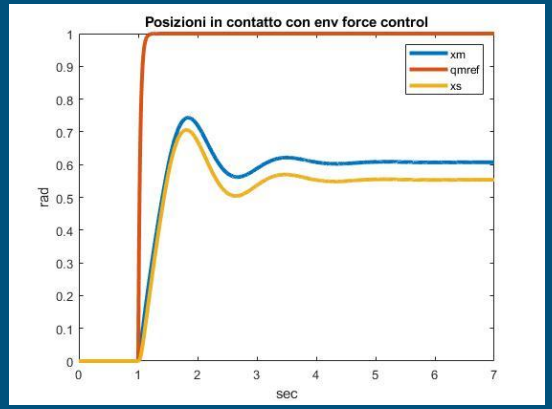


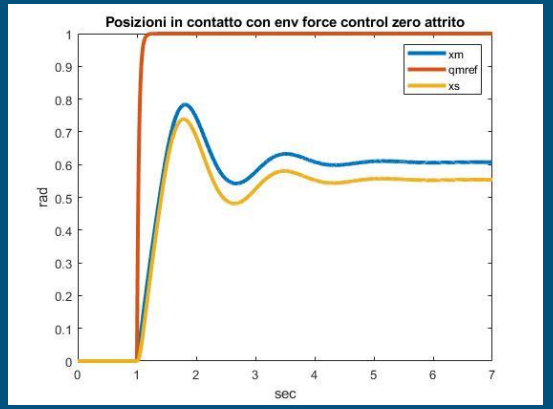


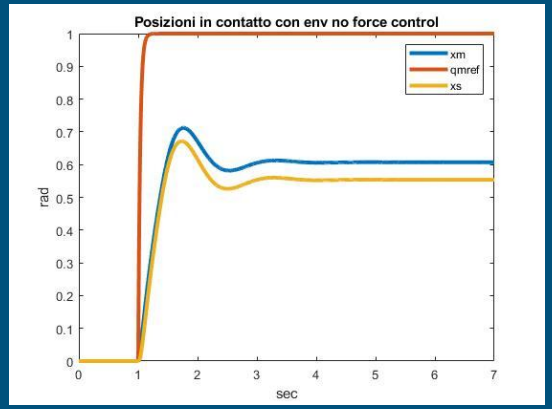


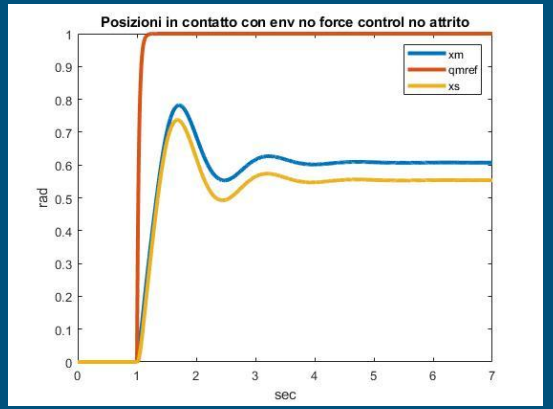
Risultati simulazione

Confronto posizioni, slave in contatto con env, (0.5 rad)



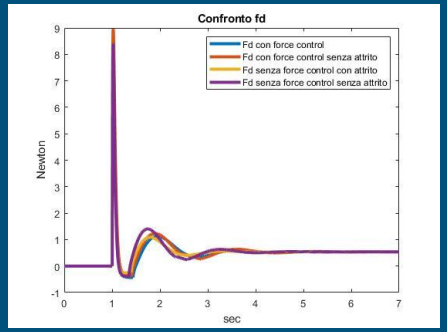


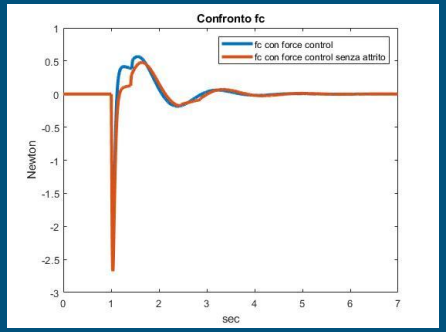


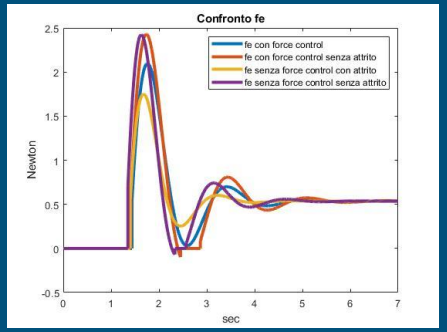


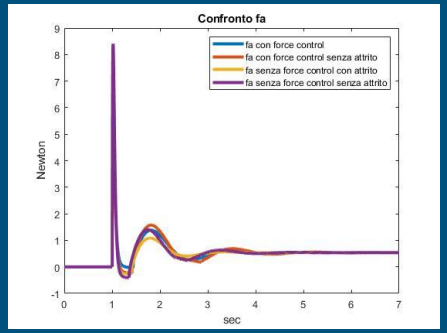
Risultati simulazione

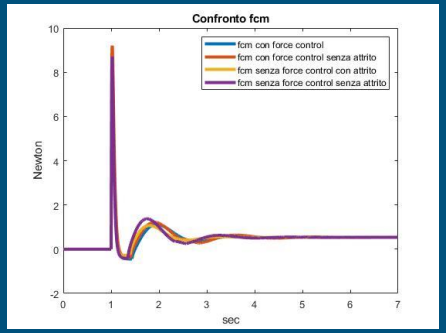
Confronto forze, slave in contatto con env, (0.5 rad)

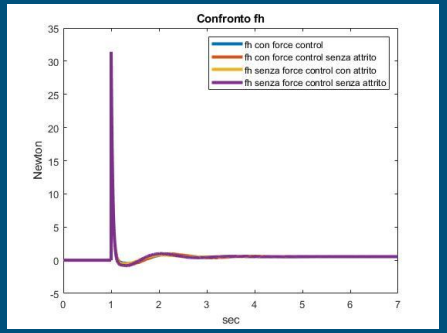






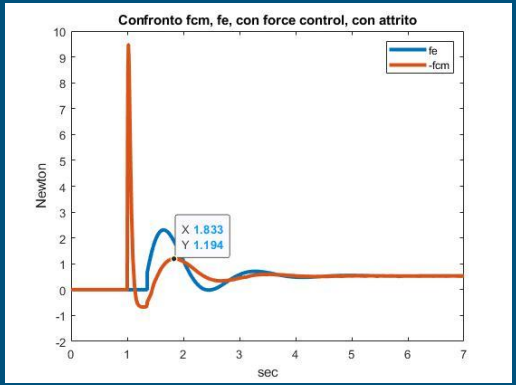


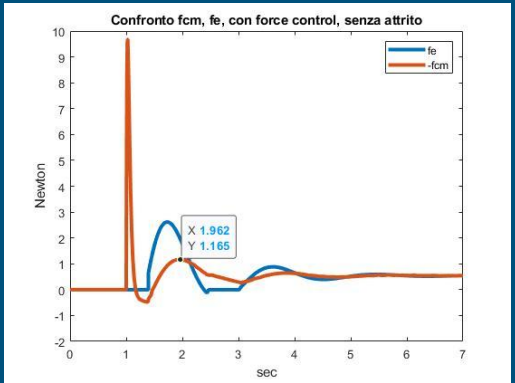


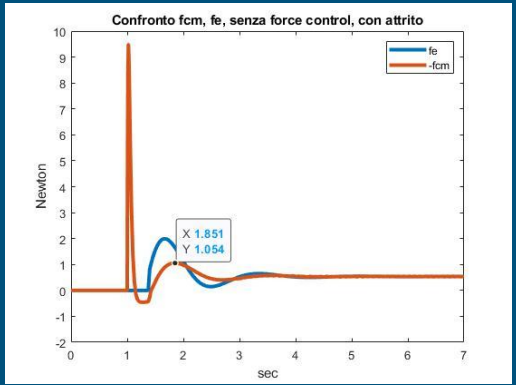


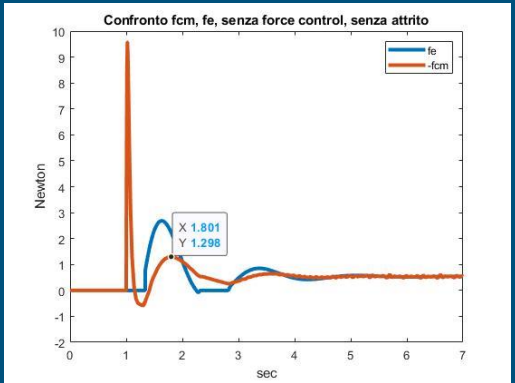
Risultati simulazione

Confronto force feed-back master e forza dell'environment



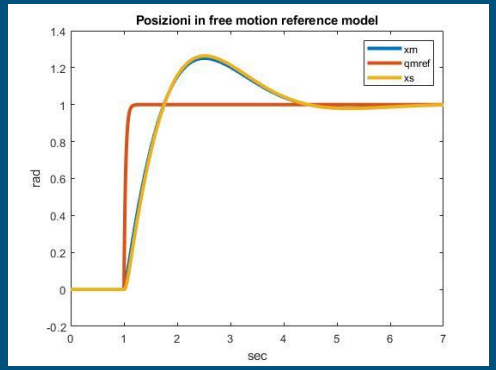


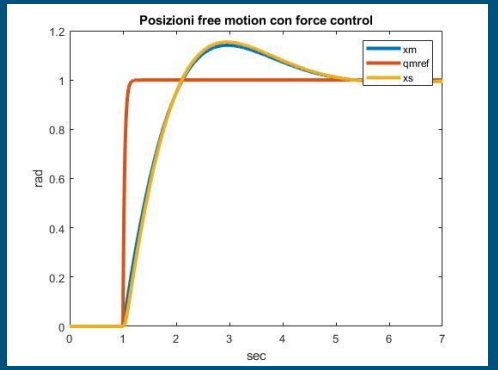


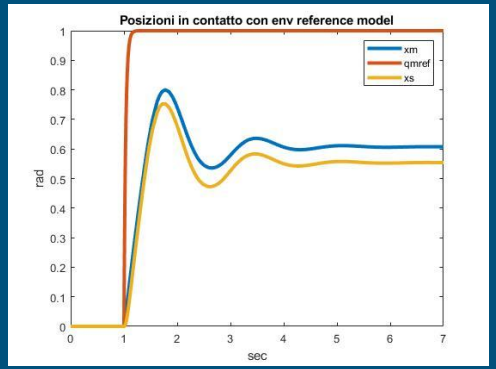


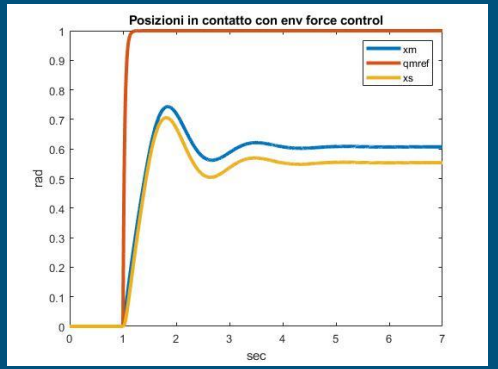
Risultati simulazione

Confronto posizioni, free motion, reference model



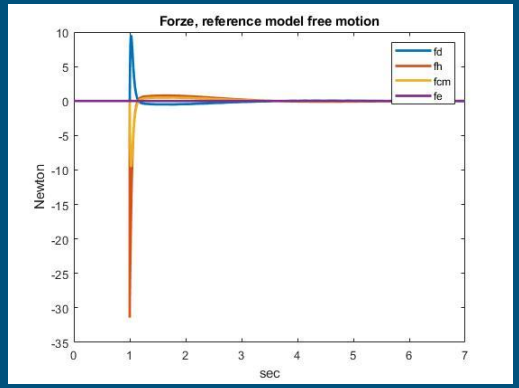


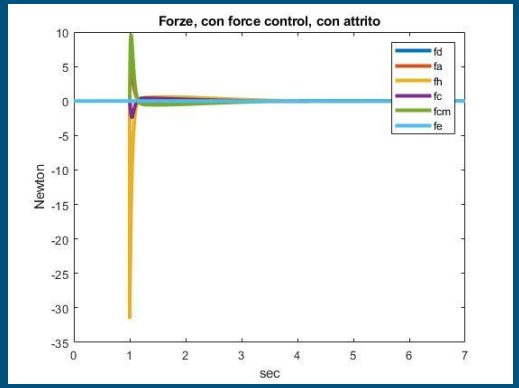


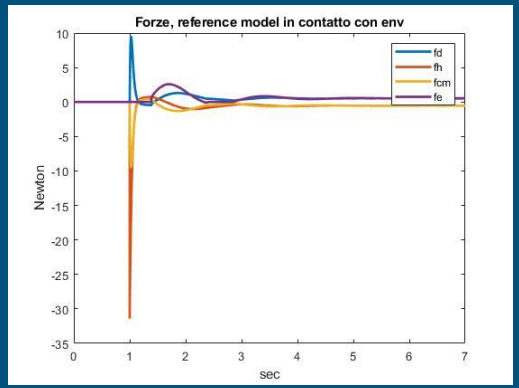


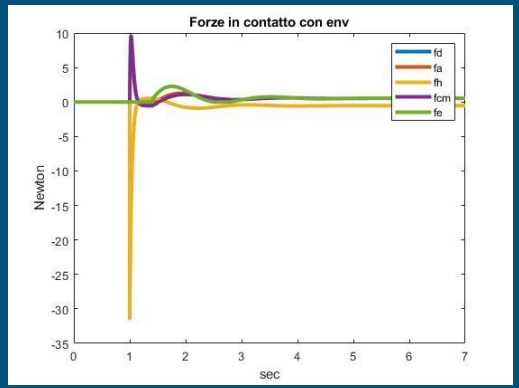
Risultati simulazione

Confronto forze, free motion, reference model



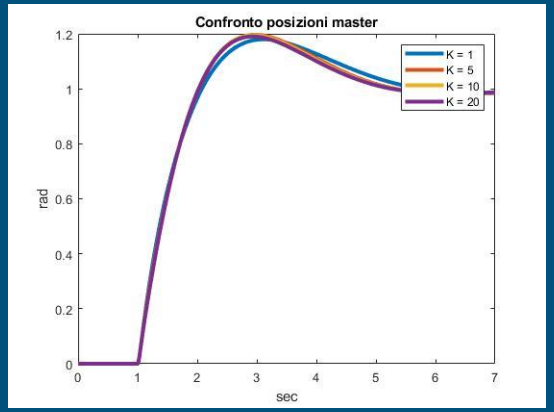


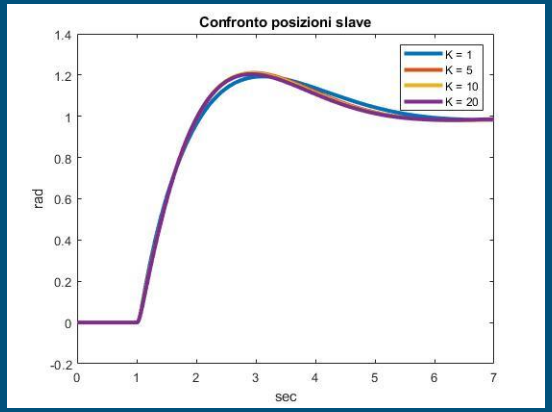


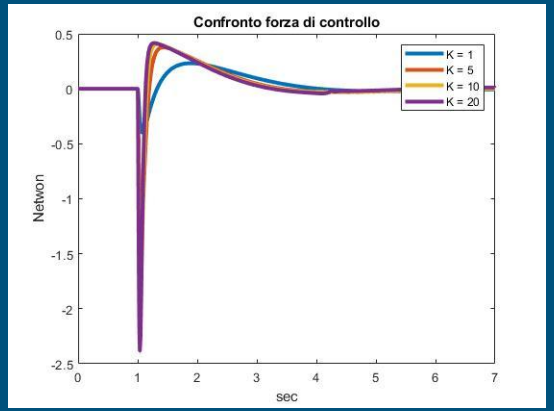


Risultati Simulazione

Confronto posizioni master slave e forze con diversi valori di K

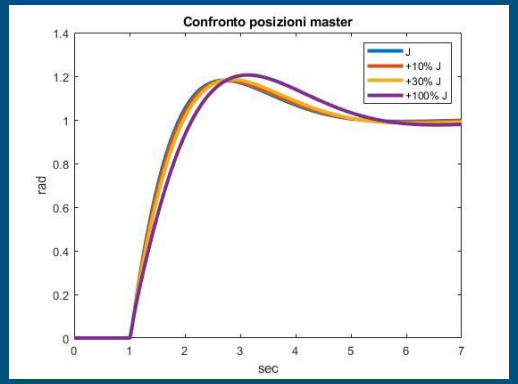


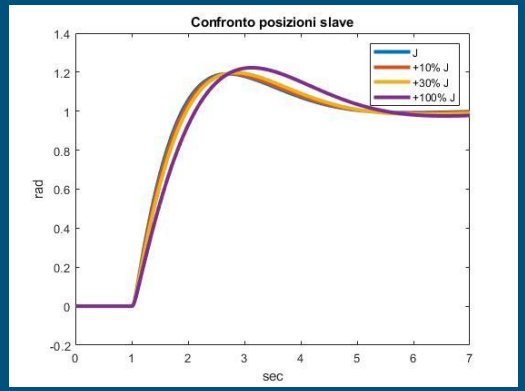


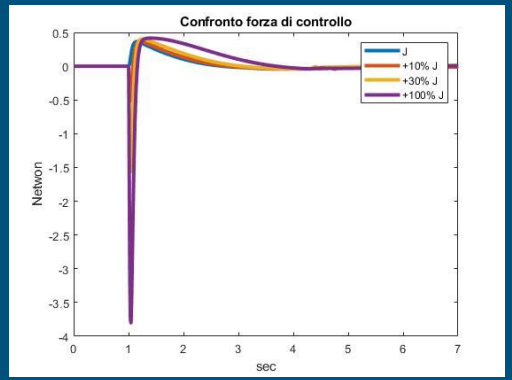


Risultati simulazione

Confronto posizioni master slave e forze con diversi valori di J_r

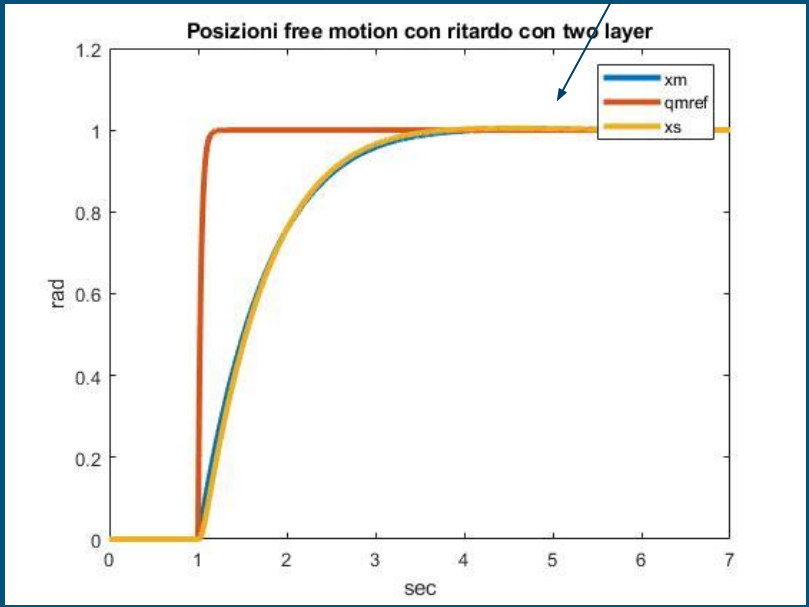


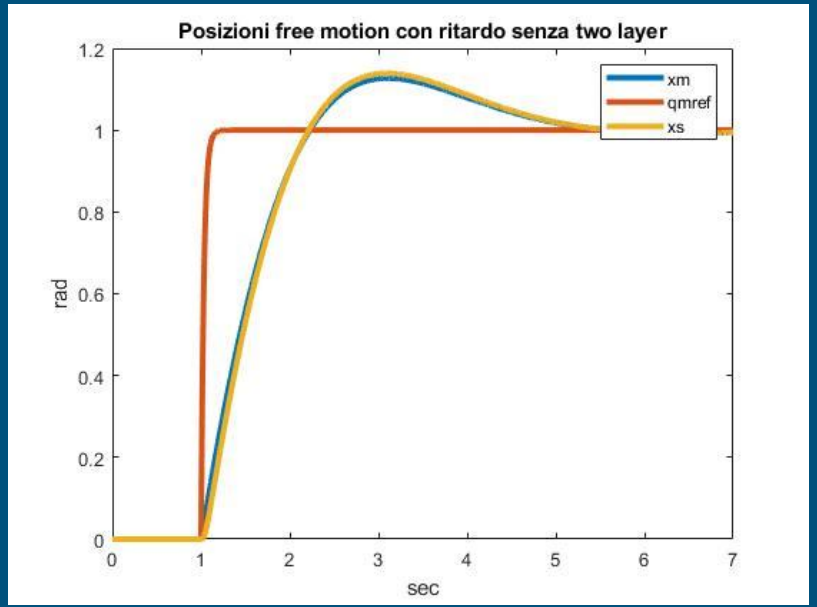




Confronto posizioni con two-layer attivo e senza two-layer in free motion con ritardo

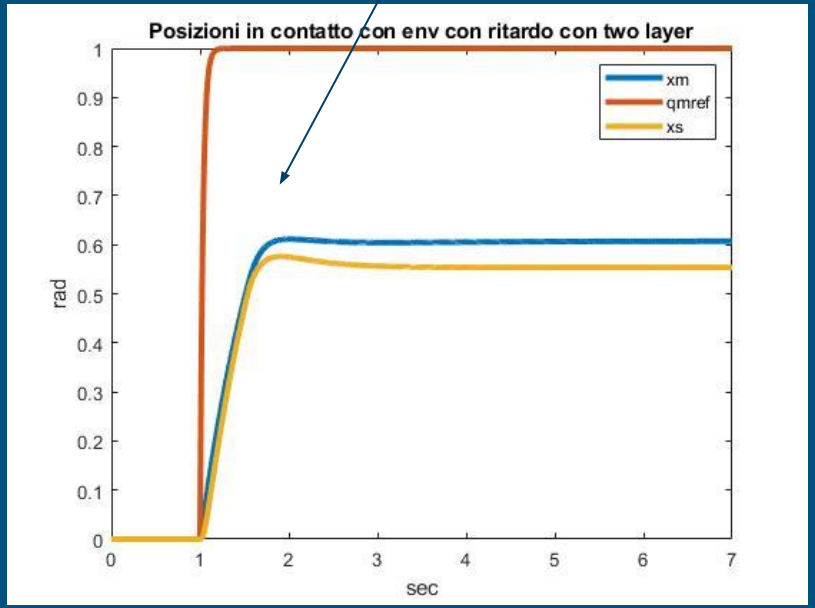
Overshoot cancellato

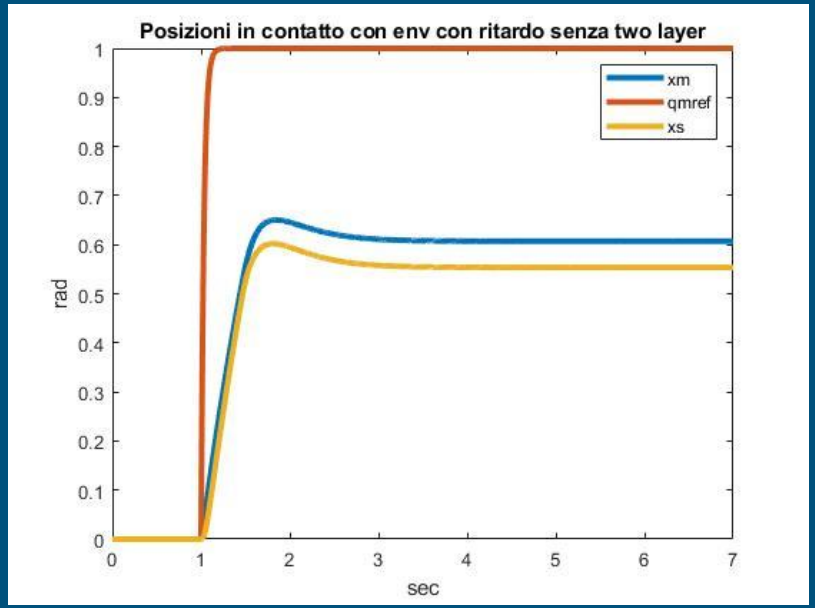




Confronto posizioni con two-layer attivo e senza two-layer in contatto con ritardo, posizione env = 0.5 (rad)

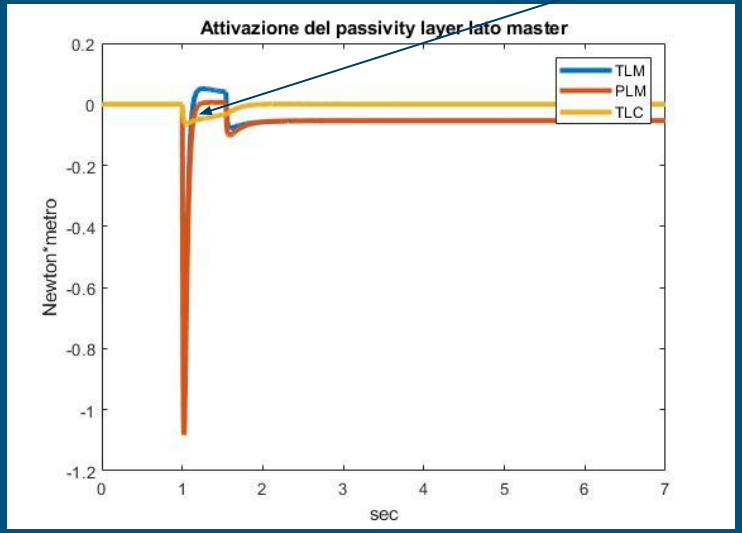
Overshoot diminuito



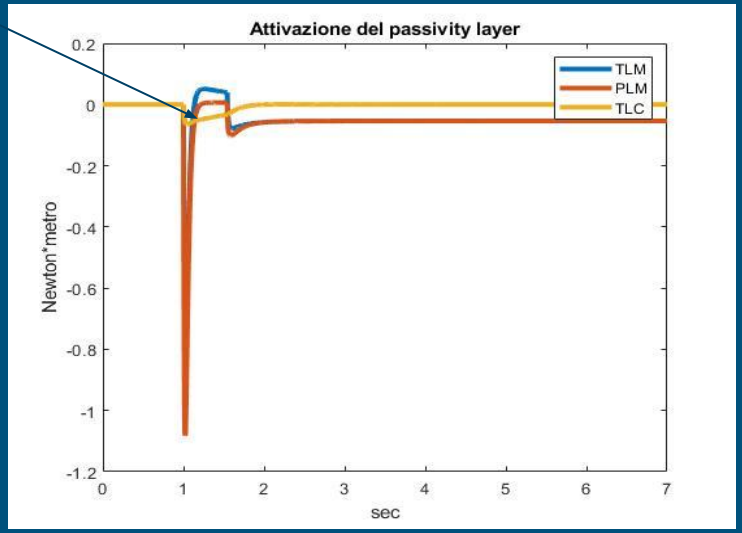


Confronto attivazione passivity-layer in free motion e in contatto con env, posizione env 0.5 (rad). Lato master.

Il passivity-layer modula la coppia fornita dal transparency-layer grazie al TLC.



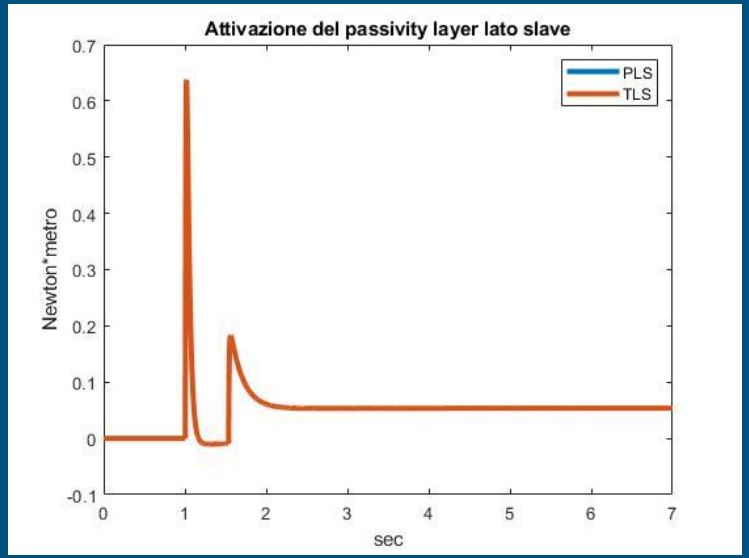
Free-motion



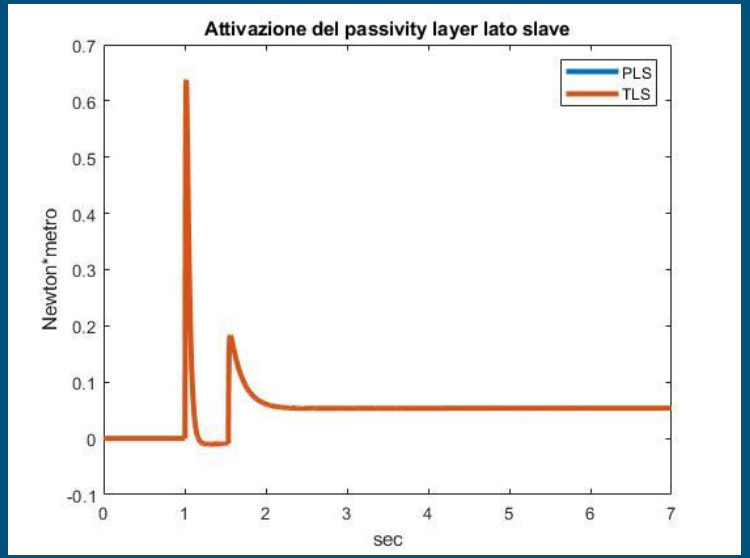
In contatto con env

Confronto attivazione passivity-layer in free motion e in contatto con env, posizione env 0.5 (rad). Lato slave.

Il passivity layer non agisce, perchè l'energia del tank non scende mai sotto il livello minimo.



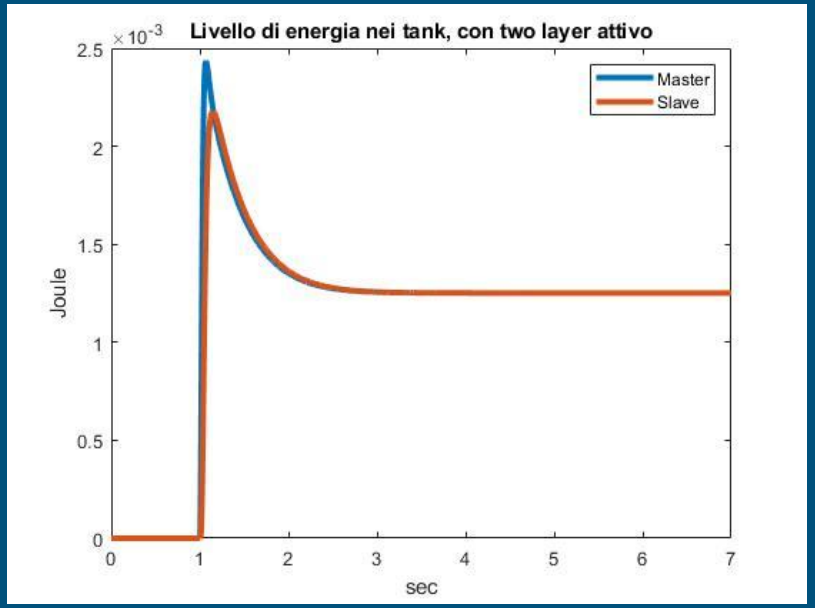
Free-motion



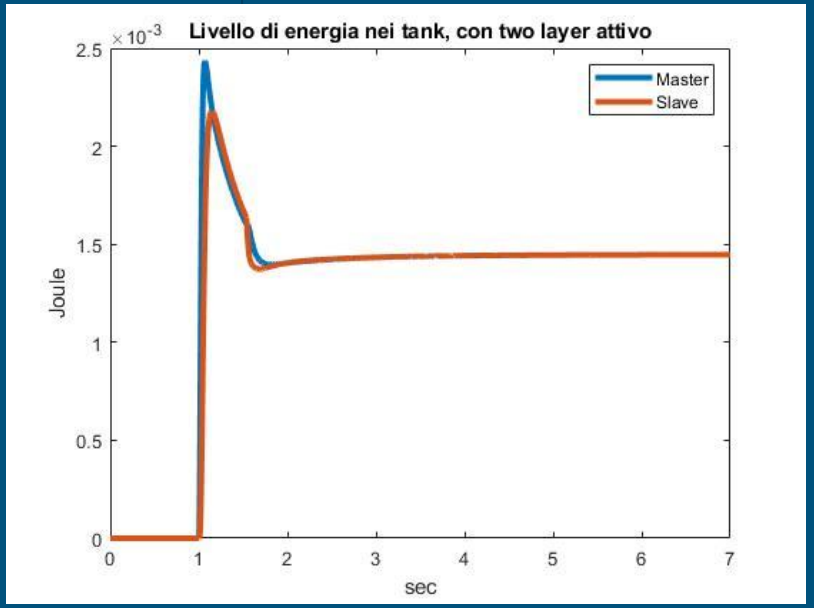
In contatto con env

Confronto livello tank in free motion e in contatto con env.

Livello Minimo = 0 (J), Livello Desiderato = 0.5 (J), Livello massimo = 1 (J)



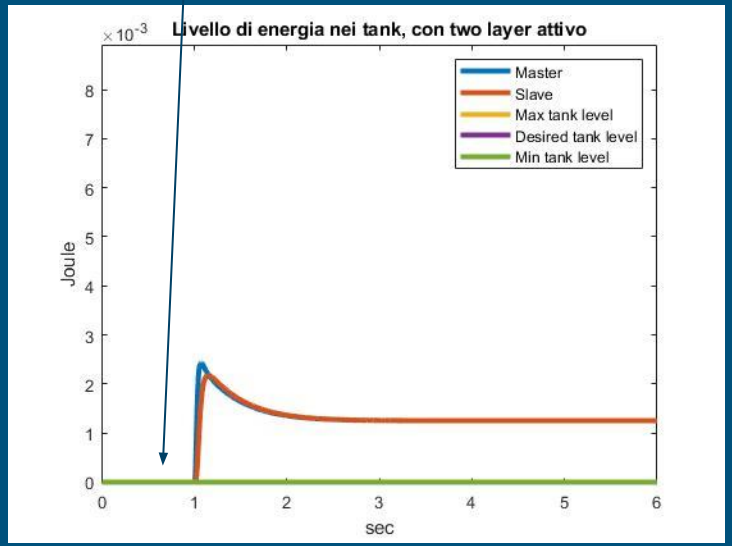
Free-motion



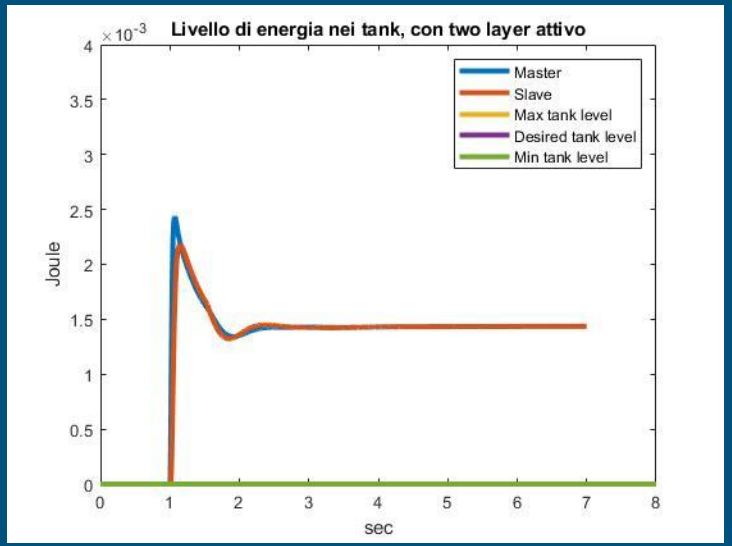
In contatto con env

Livello dei tank evidenziando il minimo

Livello Minimo = 0 (J), Livello di energia nel tank sempre sopra il livello minimo

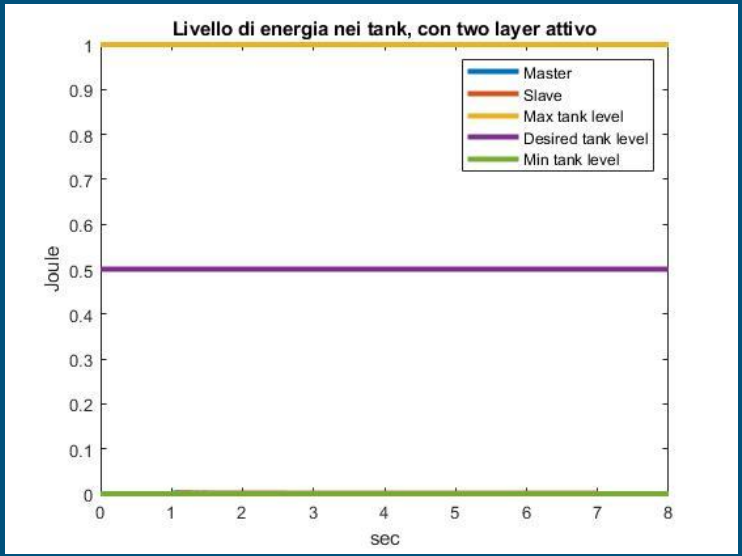


Free-motion



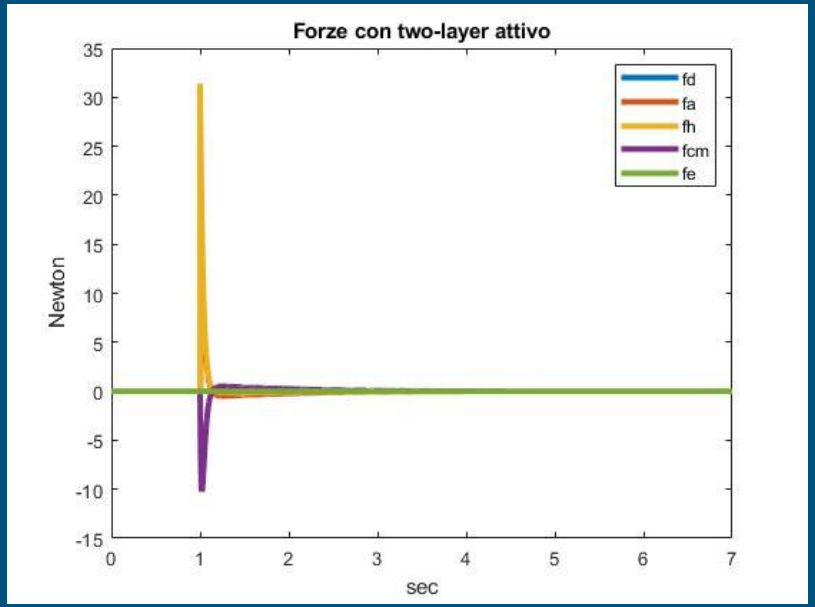
In contatto con env

Livello Massimo, desiderato e minimo dei tank.

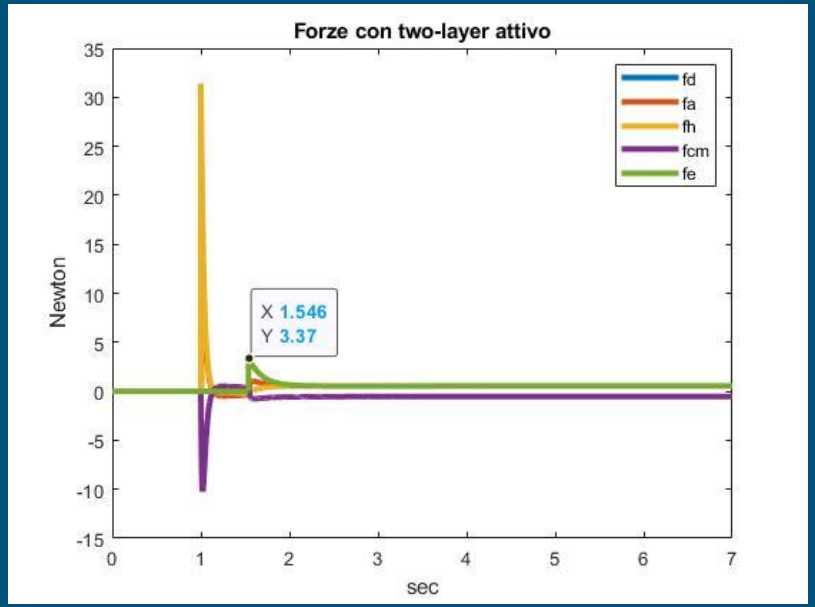


Confronto forze tra sistema in free-motion e in contatto con env, con two-layer attivo.

Fd = Forza desiderata che si vorrebbe applicare allo slave, Fa = forza veramente applicata allo slave, Fh = forza dell'operatore, Fcm = force feedback del master, Fe = forza di contatto con l'env.



Free-motion



In contatto con env