

TU Berlin Robotics WS18/19: Assignment 1

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A. Calculations

1. DH Parameters

i	a_{i-1}	a_i	d_i	θ_i
1	0	0	0	θ_1
2	0	L_1	0	θ_2
3	0	L_2	0	θ_3
4(E)	0	L_3	0	0

2. Gravity Vector

The obtained gravity vector for estimating the torque on each joint is:

$$G(q_1, q_2, q_3) = \begin{bmatrix} g(m_1 r_1 c_1 + m_2(l_1 c_1 + r_2 c_2) + m_3(l_1 c_1 + l_2 c_2 + r_3 c_3)) \\ g(m_2 r_2 c_2 + m_3(l_2 c_2 + r_3 c_3)) \\ g m_3 r_3 c_3 \end{bmatrix}$$

where:

$$\begin{aligned} c_1 &= \cos(q_1) \\ c_2 &= \cos(q_1 + q_2 - 90^\circ) \\ c_3 &= \cos(q_1 + q_2 + q_3 - 90^\circ) \end{aligned}$$

B. Implementation

2. Tune the controllers

Behaviors

When tuning the gains one can observe that initially the system tends to oscillate and later on, when the gains are correctly tuned, the system tends to overshoot. Overall it is difficult to obtain a steady behavior only by implementing a P controller.

Differences in each joints' gain

Each joint have a different value for the gain, as a result of the position of the links that are part of the joint and the overall effect that the movement of links have in the whole system. Other factors that influence the value of the gains are, of course, the mass and length of the links.

3. Document Behavior

njmoveControl response

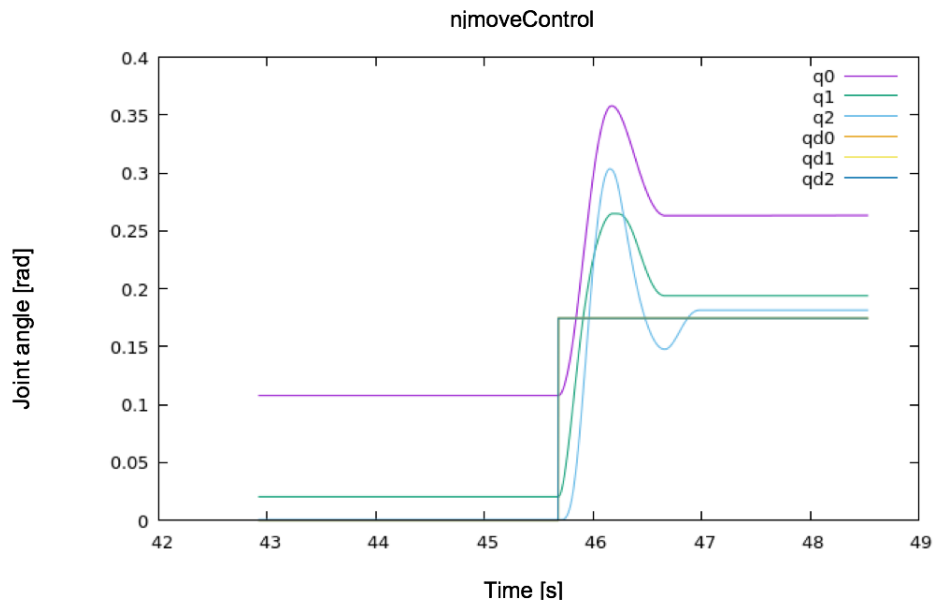


Figure 1: njmoveControl angle comparison

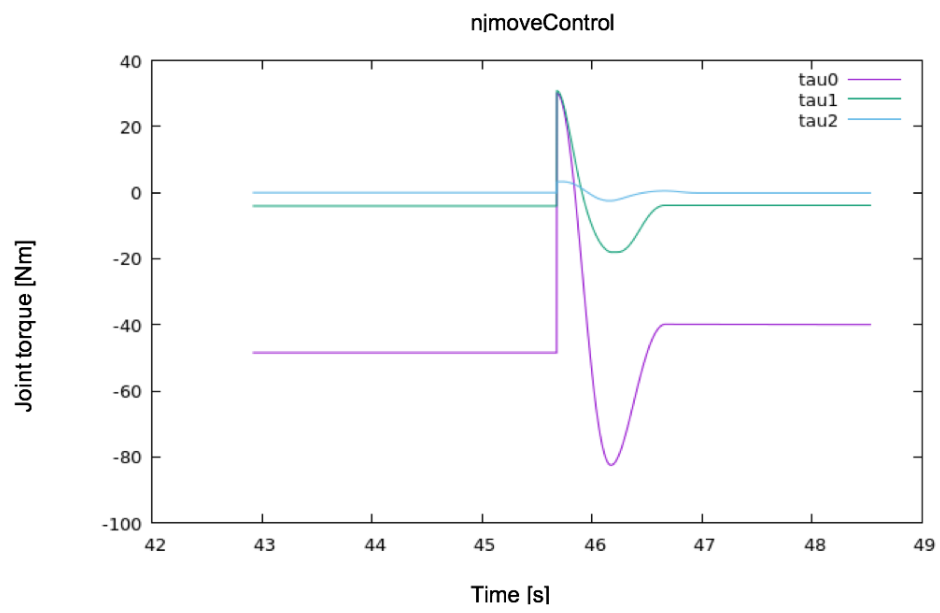


Figure 2: njmoveControl torque comparison

njgotoControl response

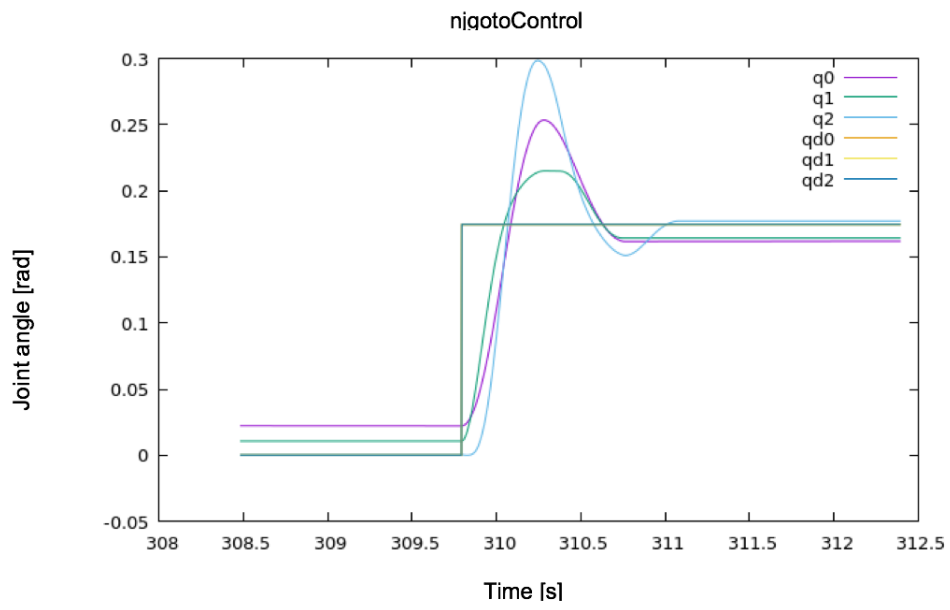


Figure 3: njgotoControl angle comparison

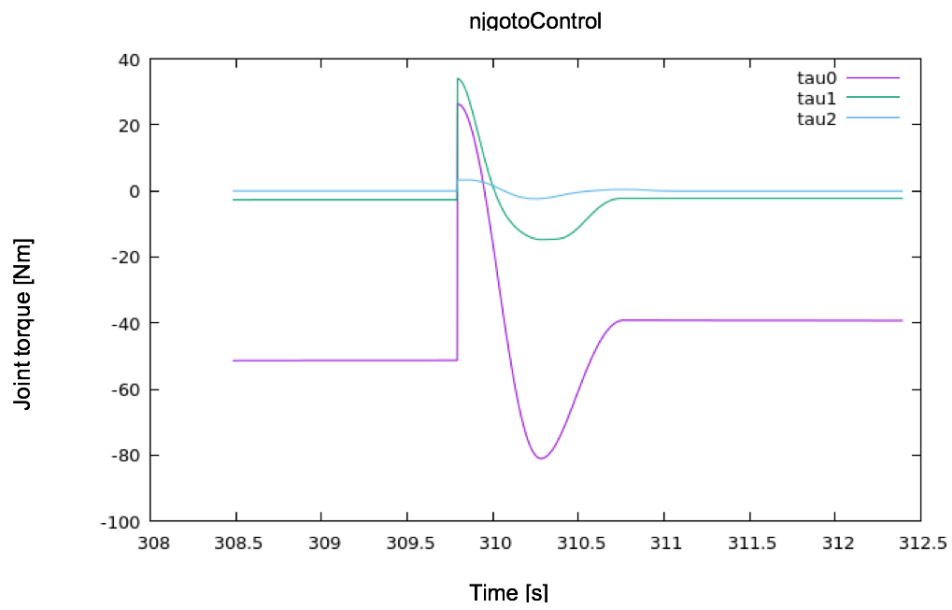


Figure 4: njgotoControl torque comparison

jgotoControl response

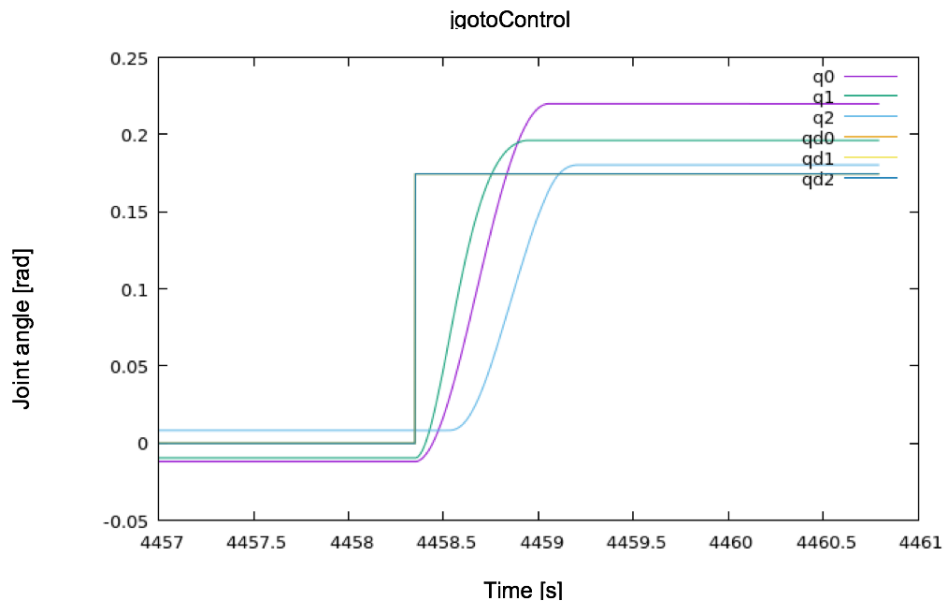


Figure 5: jgotoControl angle comparison

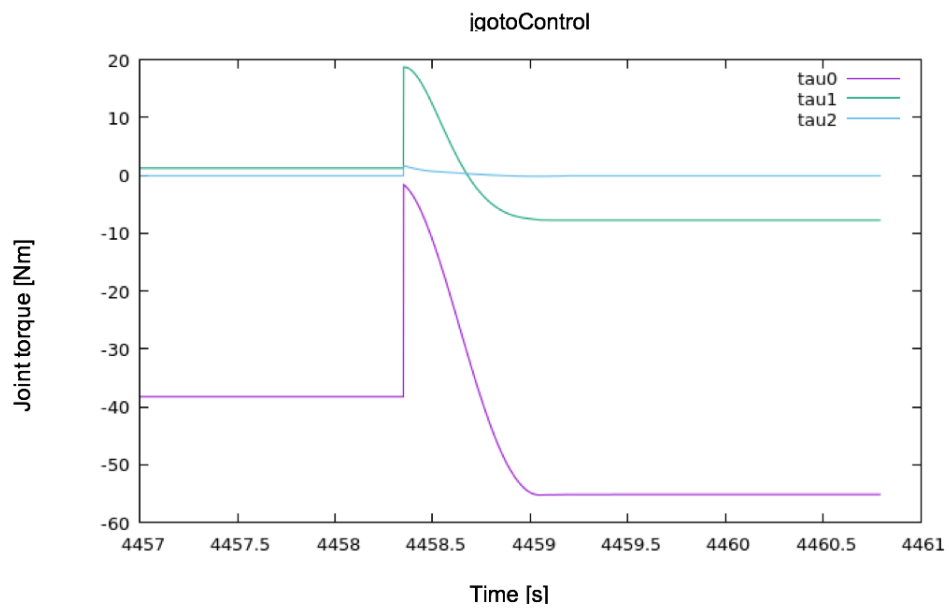


Figure 6: jgotoControl torque comparison

7. PD controller

The gains k_p in the PD controller tend to be higher as the derivative part of the controller avoids the overshooting and decreases the settling time, opposite from the P controller.

Implementation Table

Student Name	B1	B2	B3	B4	B5	B6	B7
Dhananjay Mukhedkar	X	X	X	X	X		
Jiaqiao Peng	X					X	X
Mayank Gulati	X	X	X	X	X		
Sergio Omar Lezama Ruvalcaba	X	X	X	X			