Robotics

Assignment 1

Group Fr-1B
Bharathwaj KS
Kyra Kerz
Abhiraj Bishnoi
Robin Scholtz

Winterterm 18/19
TECHNISCHE UNIVERSITÄT BERLIN

4. November 2018

A - Calculations

1. Find the DH parameters for the 3-DOF RRR Puma

i	α_{i-1}	a_{i-1}	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. Compute the gravity vector $G(q_1, q_2, q_3) = [?\ ?\ ?]^T$

Torque produced by weights m1,m2,m3 on joints 1,2,3 :

$$G = \begin{bmatrix} g \cdot \{m_1 \cdot r_1 \cdot c_1 + m_2 \cdot (L_1 \cdot c_1 + r_2 \cdot c_{12}) + m3 \cdot (L_1 \cdot c_1 + L_2 \cdot c_{12} + r_3 \cdot c_{123})\} \\ g \cdot \{m_2 \cdot r_2 \cdot c_{12} + m_3 \cdot (L_2 \cdot c_{12} + r_3 \cdot c_{123})\} \\ g \cdot m_3 \cdot r_3 \cdot c_{123} \end{bmatrix} Nm$$

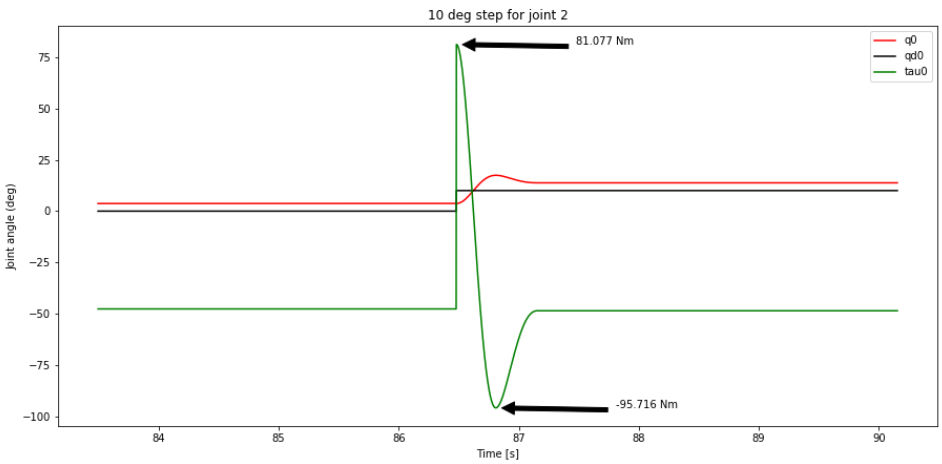
$$c_1 = \cos(\theta_1)$$
$$c_{12} = \cos(\theta_1 + \theta_2 - \pi/2)$$
$$c_{123} = \cos(\theta_1 + \theta_2 + \theta_3 - \pi/2)$$

B - Implementation

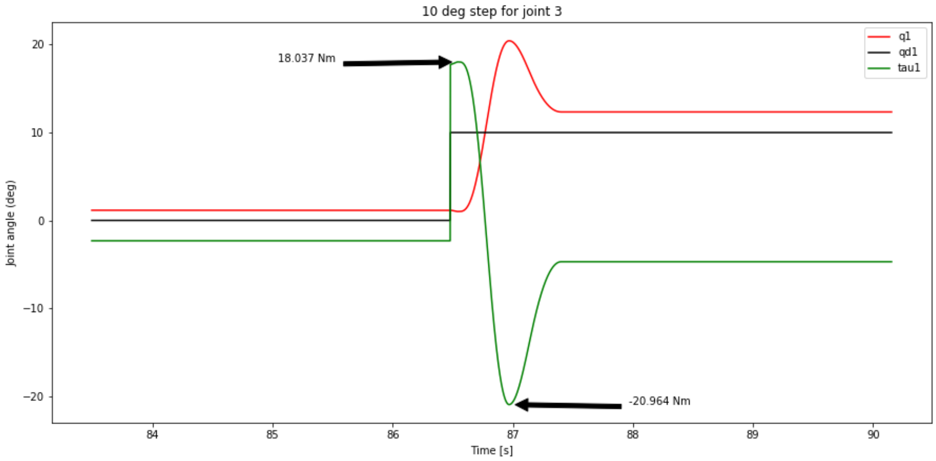
3. K_p values

Joints	2	3	5
K_p	737.1	115	20.1

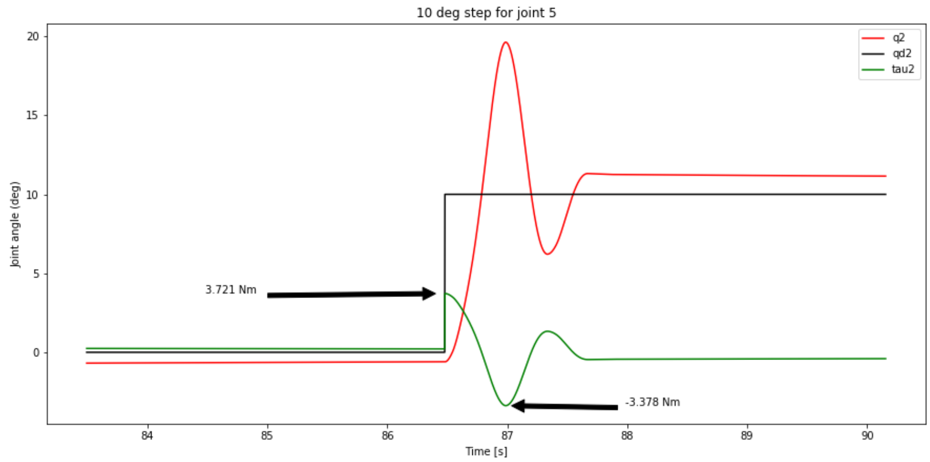
3.1 Joint 2



3.2 Joint 3



3.3 Joint 5



3.4 Observations

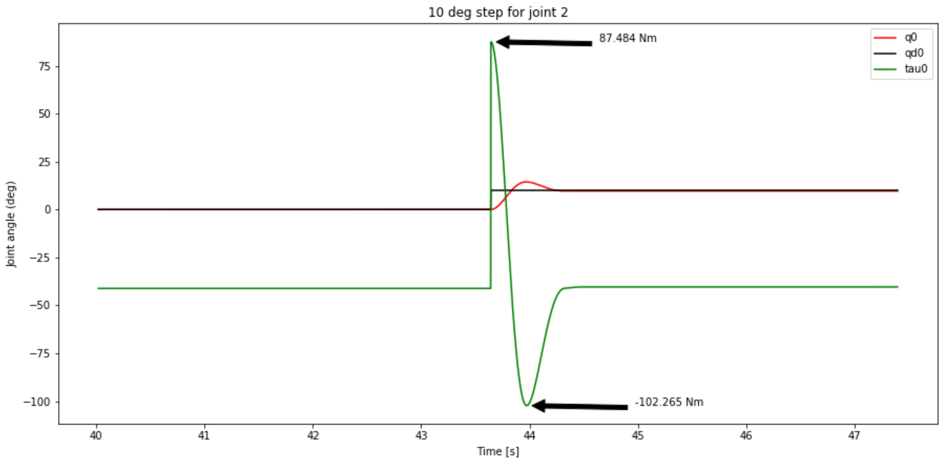
Q. What kind of behaviors do you observe with different gains?
Ans. With high values for K_p we can observe that the overshoot increases, more oscillations are induced and error is reduced. It causes the joint to reach the desired angle quicker. With lower values, overshoot is reduced and oscillations are minimum but the error is high.

Q. Why are well tuned gains different for each joint?
Ans. K_p depends on the parameters of the joint and the link, like mass, friction acting on the joint, link length etc. Depending on how responsive the joint must be, we decide on the K_p values.

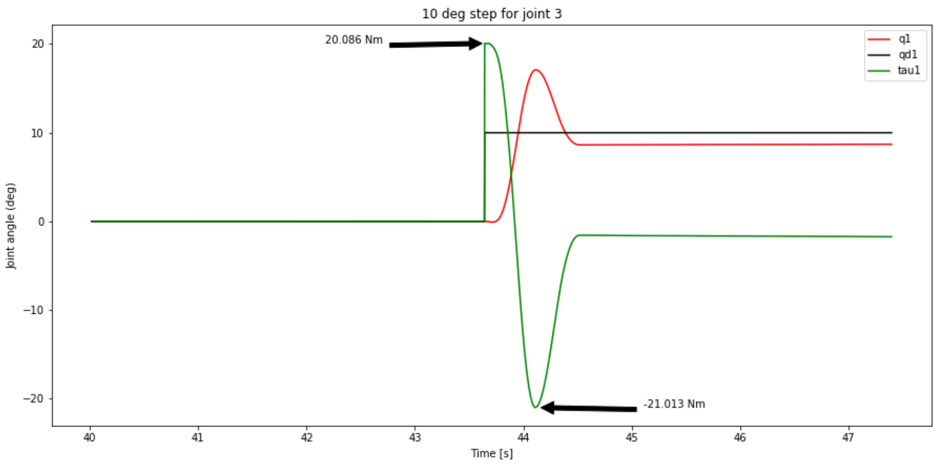
6. K_p values

Joints	2	3	5
K_p	737.1	115	20.1

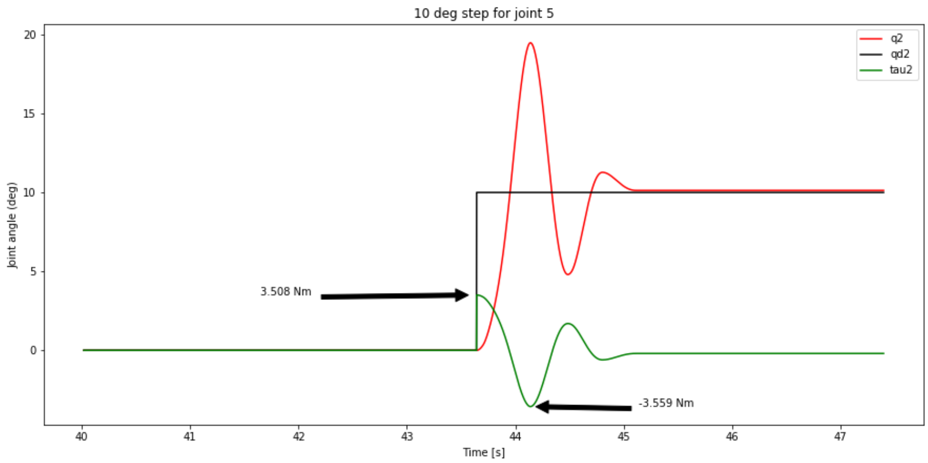
6.1 Joint 2



6.2 Joint 3



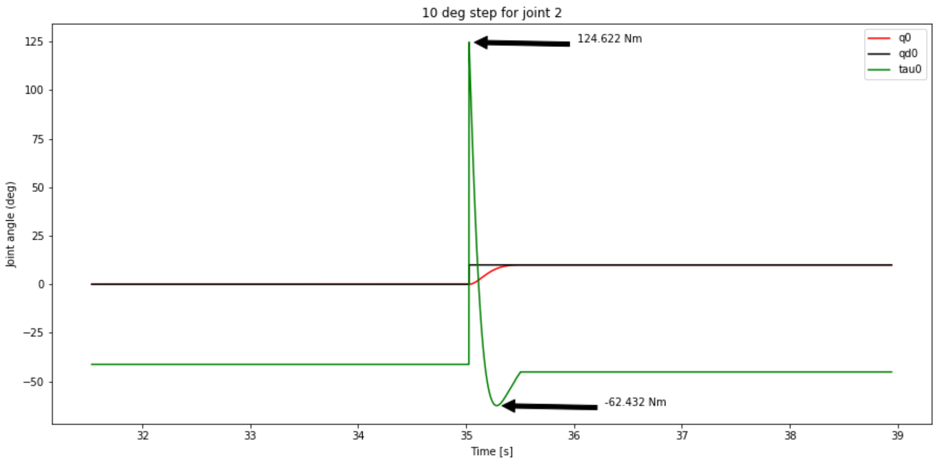
6.3 Joint 5



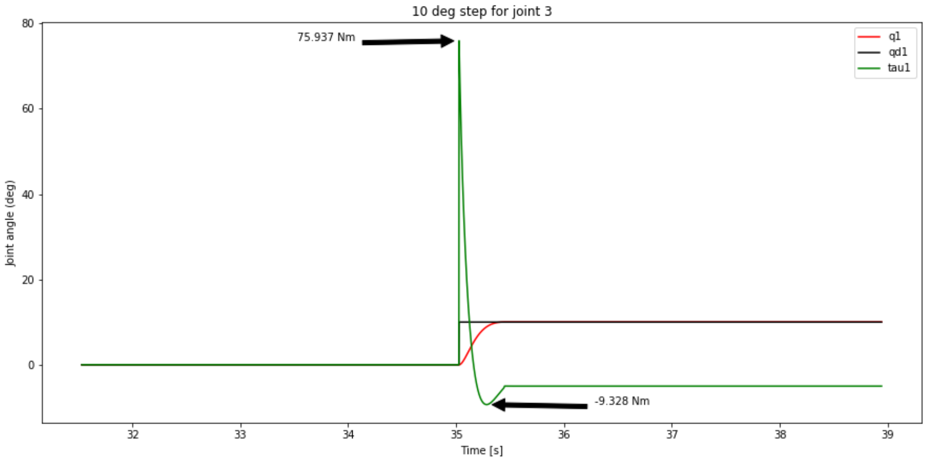
7. Gain values

Joints	2	3	5
K_p	950.1	435	80.1
K_v	125	45	10

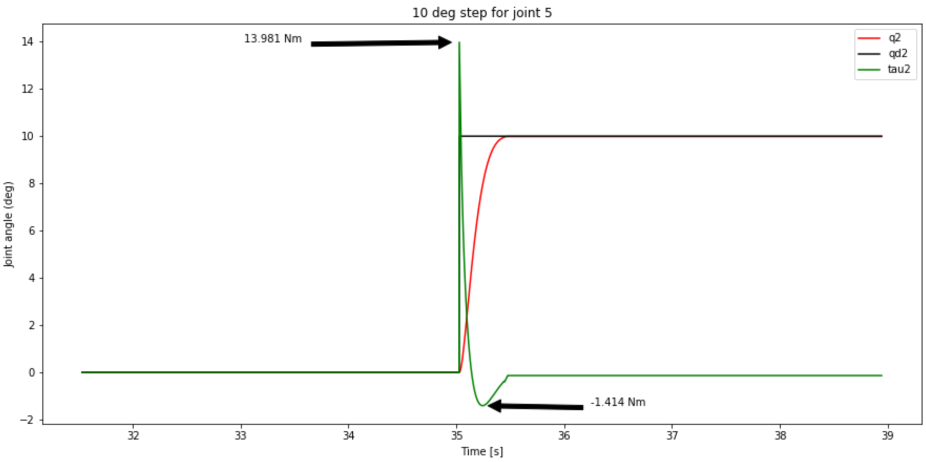
7.1 Joint 2



7.2 Joint 3



7.3 Joint 5



7.4 Observations

Q. Why can the gains K_p now be higher compared to the P-controller?
Ans. With high K_p values, the system is more prone to overshoot and oscillations. To negate this we require a damper. The derivative controller acts as a damper. With it we can use higher values for K_p by properly tuning K_v to avoid overshoot.

C - Implementation tasks table

Student Name	**B(1)**	**B(2)**	**B(3)**	**B(4)**	**B(5)**	**B(6)**	**B(7)**
Bharathwaj KS	x	x	x	x	x		x
Kyra Kerz	x	x	x	x		x	x
Abhiraj Bishnoi	x	x	x	x			
Robin Scholtz	x	x	x	x	x	x	x