Report for HomeWork 4

1) For the first task we had to calculate the Jacobians. All important steps were introduces in “Task1” matlab file. First of all, forward kinematics matrix was calculated. Where all angles are 30,60 and 30 degree respectively. The result is shown on the figure1.

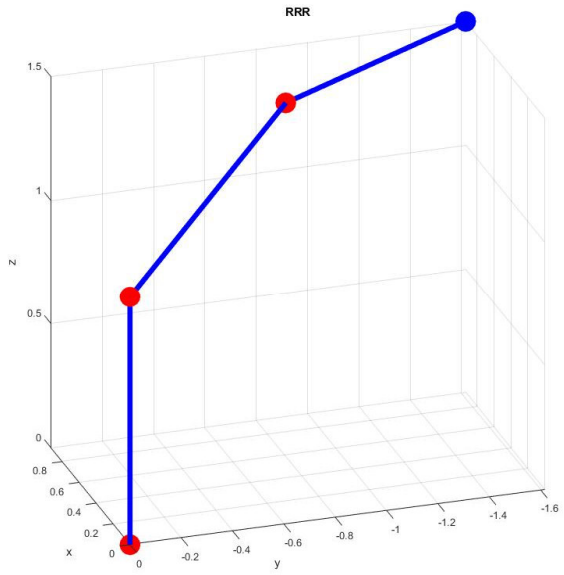


Figure 1 – The RRR robot, with 30,60 and 30 degree angles.

Then, T1 T2 and T3 matrices are the matrices of the first, second and the third joint. By using those matrices we may find the exact coordinate and z_i parameter for every joint. In our case, all three joints are revolute, so $J_{v_i} = z_{i-1} \times (o_n - o_{i-1})$,where o_n – is the coordinate of the end-effector and o_i is a coordinate a the joint which index is number i .

2) In this task, our trajectory q(t) will be 5 degree polynomial equation. Due to the fact, that we have 6 constraints. So we have to find a0,a1,a2,a3,a4,a5 coefficients. We may use the method

that is shown on the figure 2.

- Combined the six equations into a single matrix equation.

$$\begin{bmatrix} a_0 \\ a_1 \\ a_2 \\ a_3 \\ a_4 \\ a_5 \end{bmatrix} = \begin{bmatrix} 1 & t_0 & t_0^2 & t_0^3 & t_0^4 & t_0^5 \\ 0 & 1 & 2t_0 & 3t_0^2 & 4t_0^3 & 5t_0^4 \\ 0 & 0 & 2 & 6t_0 & 12t_0^2 & 20t_0^3 \\ 1 & t_f & t_f^2 & t_f^3 & t_f^4 & t_f^5 \\ 0 & 1 & 2t_f & 3t_f^2 & 4t_f^3 & 5t_f^4 \\ 0 & 0 & 2 & 6t_f & 12t_f^2 & 20t_f^3 \end{bmatrix}^{-1} \begin{bmatrix} q_0 \\ v_0 \\ \alpha_0 \\ q_f \\ v_f \\ \alpha_f \end{bmatrix}$$

Figure 2 – the method of finding parameters

The result is shown on the figure 3.

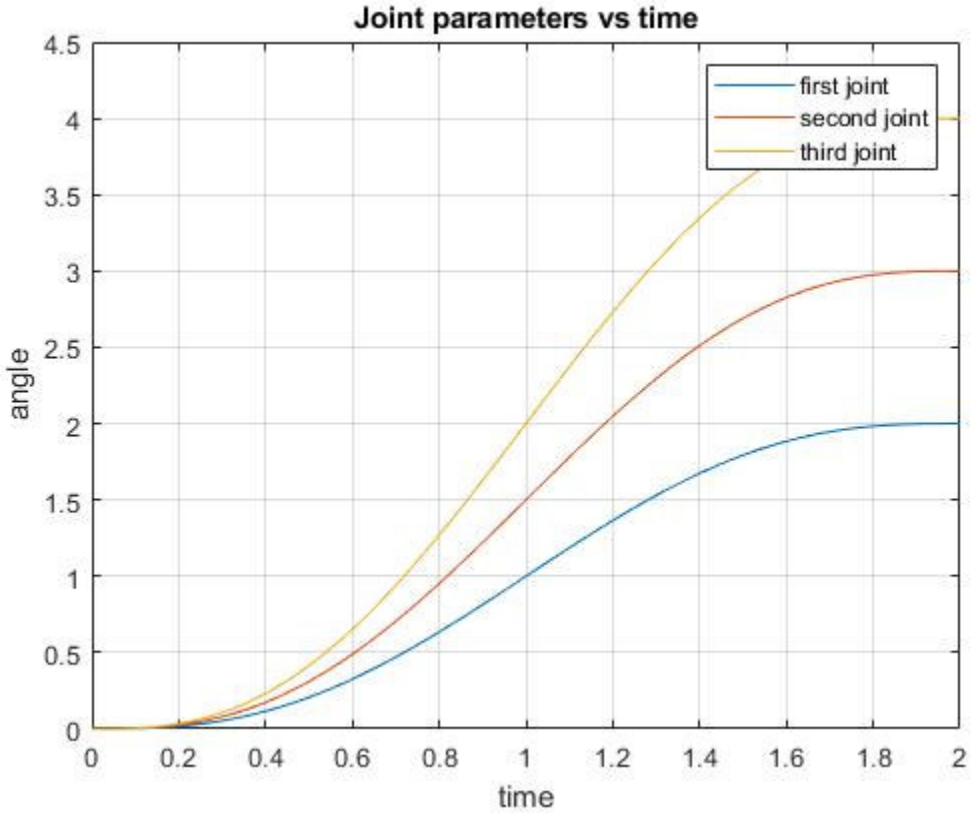
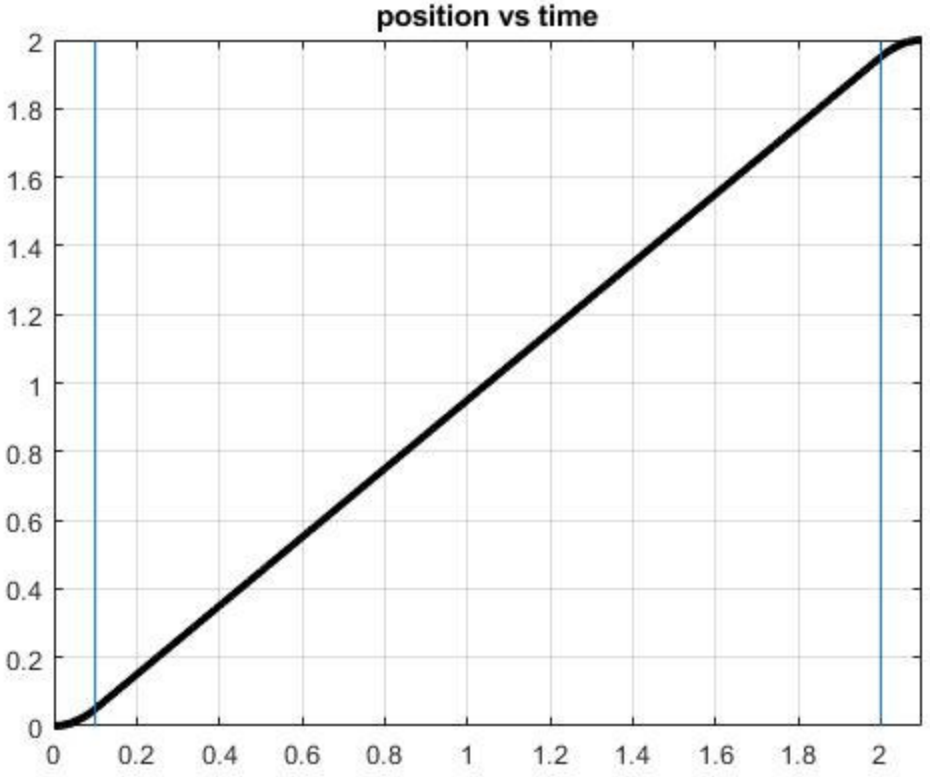
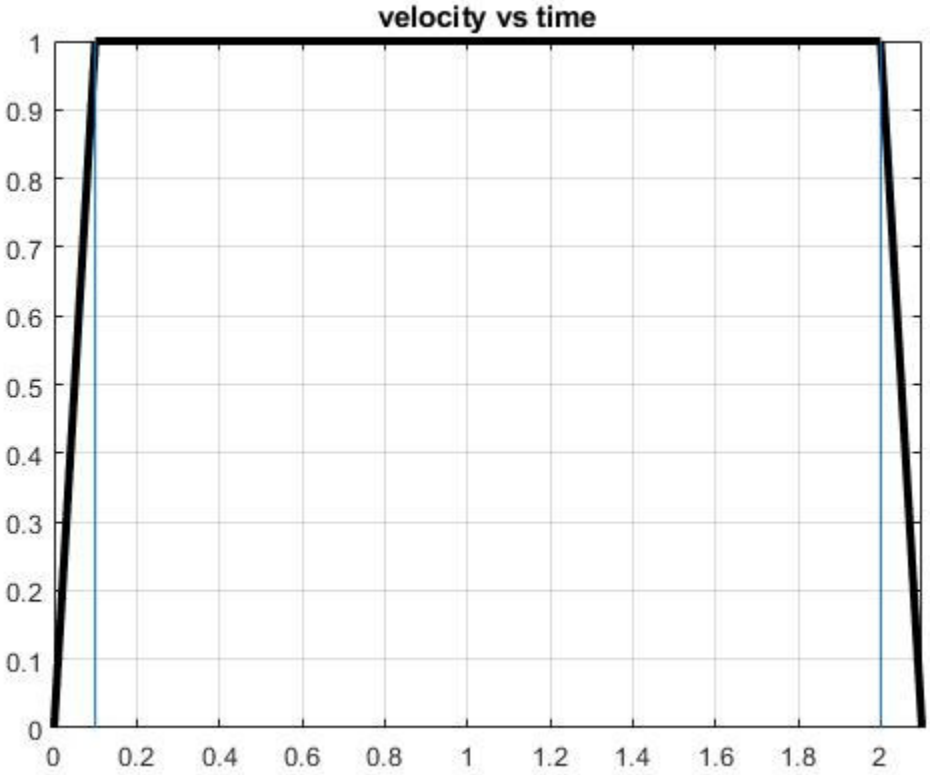
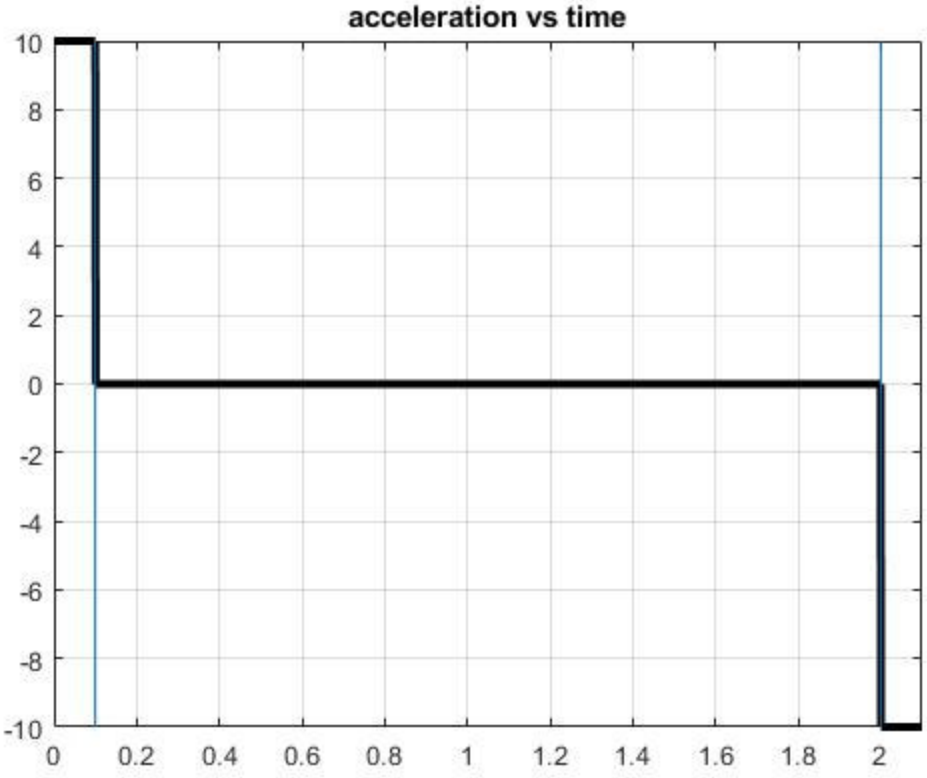


Figure 3 – Joint trajectory for all joints

3) In Task 3, we had to find the trajectory. Let's describe the first joint, then another joints will be the same. q0 = 0 and qf = 2. Maximal velocity is 1 and maximal acceleration is 10 . If the velocity is the trapezoidal form, it reaches its maximal value, after moves with a constant value and finally, achieves zero at qf.


position vs time
2
1.8
1.6
1.4
1.2
1
0.8
0.6
0.4
0.2
0
0
0.2
0.4
0.6
0.8
1
1.2
1.4
1.6
1.8
2


velocity vs time
1
0.9
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0
0
0.2
0.4
0.6
0.8
1
1.2
1.4
1.6
1.8
2



Link to the project on github

https://github.com/adilermek1/HomeWork4-DnRs.git