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**Lab: Industrial Networks and Power Electronics Laboratory (INPEL)**

Class: MECHANICS AND CONTROL OF ROBOT MANIPULATORS

Instructor: Prof. Kang, Hee-Jun

Home Work 7

The current configuration of the two link manipulator is given below as you can see the class material for chap.6.

Real parameter m1= 5kg; m2= 3kg; l1=l2= 0.5m

θ1(0) = 300; θ1(tf) = 1500 tf= 0.5 sec



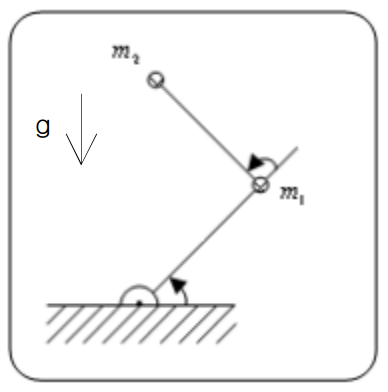
θ2(0) = 1200; θ2(tf) = 300



1. Do trajectory planning with a cubic polynomial for the two joints of the manuipulator.

Using the dynamic equation in text.

1. Perform PD control simulation (Simulink is also accepted)
2. Perform PD + gravity control simulation.
3. Perform computed torque control simulation
4. Compare errors of 3 cases above



Solutions

1. Set up cubic trajectory:

θ1(0) = 300= π/6 θ1(tf) = 1500= 5π/6

θ2(0) = 1200= 2π/3 θ2(tf) = 300= π/6

By the innitial condition:

By the final condition:

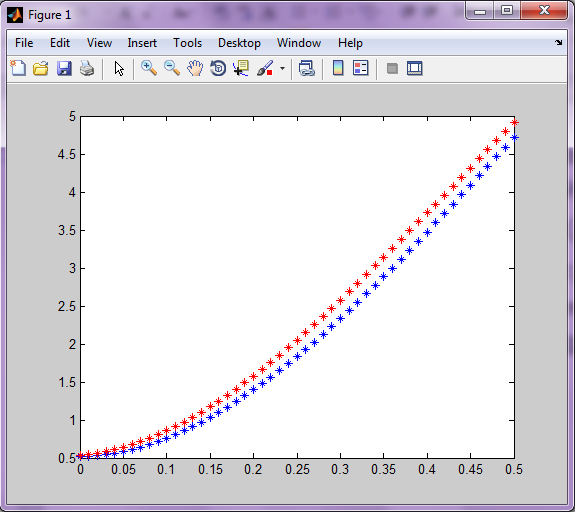
Then:

We got the result:

Find Torque Trajectory for the obtained trajectory:

Use Matlab to calculate, we got this result as follow:

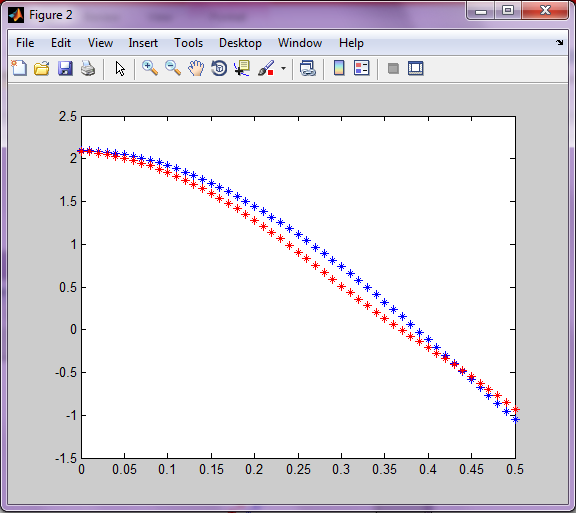
The angle trajectory and error:



Real angle

Desired angle

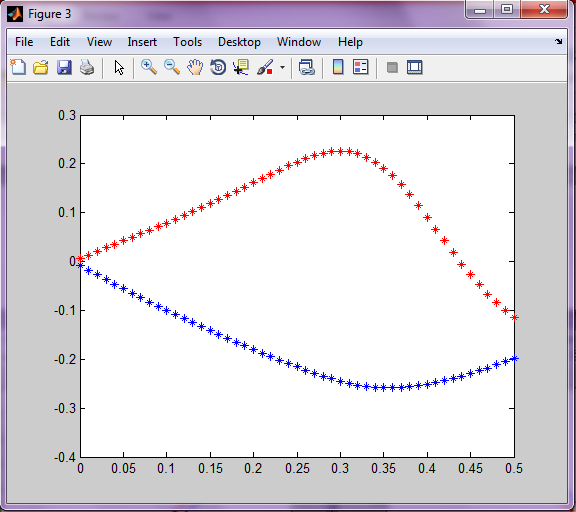
Figure 1. Angle trajectory of joint 1



Real angle

Desired angle

Figure 2. Angle trajectory of joint 2

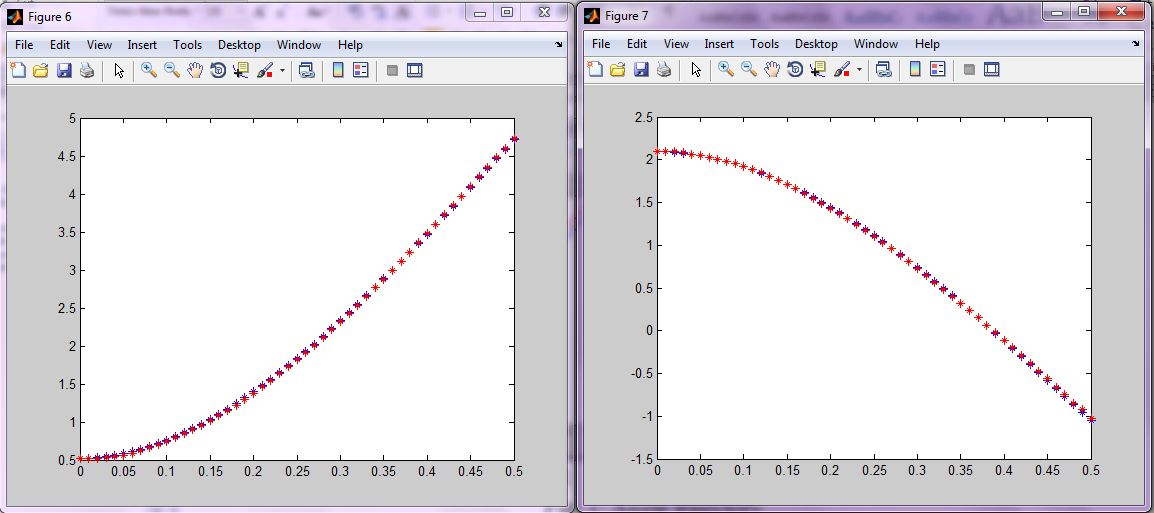


Link 2

Link 1

Figure 3. Error of the joint angle

1. Perform PD control:



(a) (b)

Figure 4. Angle trajectory of PD control: a) angle of joint 1, b) angle of joint 2

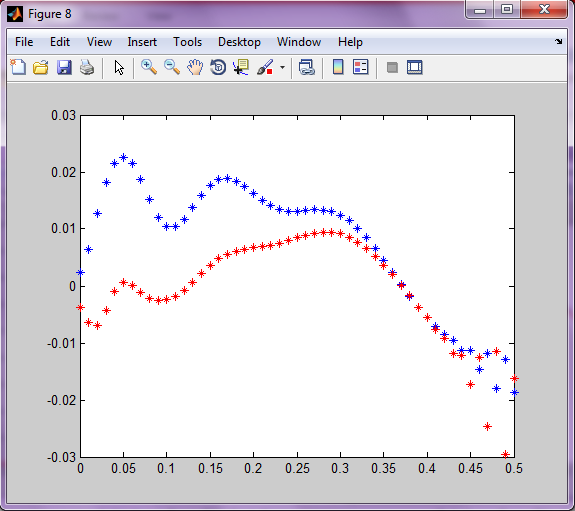
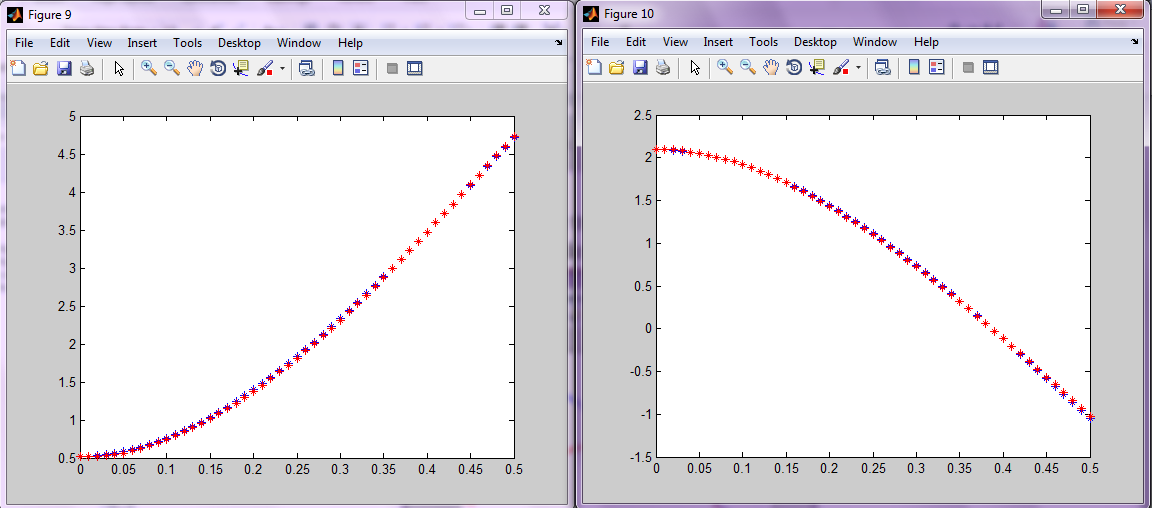


Figure 5. Error of the joint angles

1. Perform of PD + gravity control



(a) (b)

Figure 6. Angle trajectory of PD + gravity control: a) angle of joint 1, b) angle of joint 2

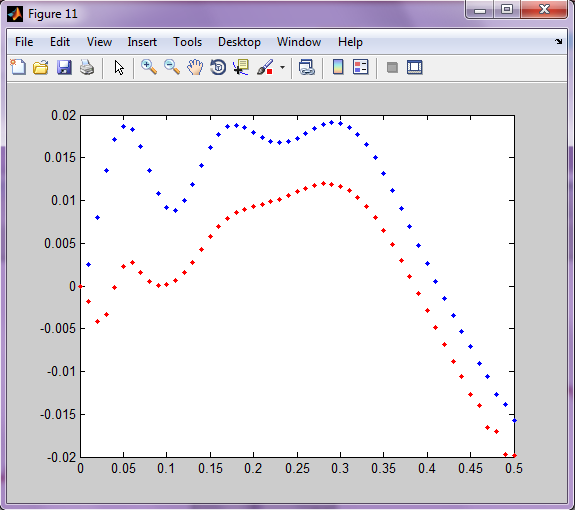
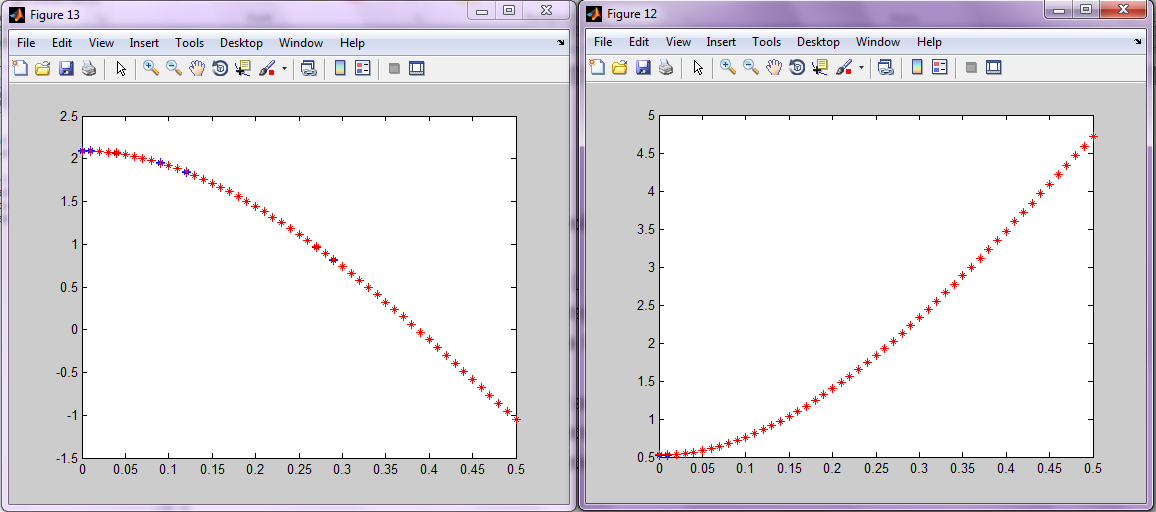


Figure 7. Error of the joint angles

1. Perform compute torque control



(a) (b)

Figure 8. Angle trajectory of compute torque control: a) angle of joint 1, b) angle of joint 2

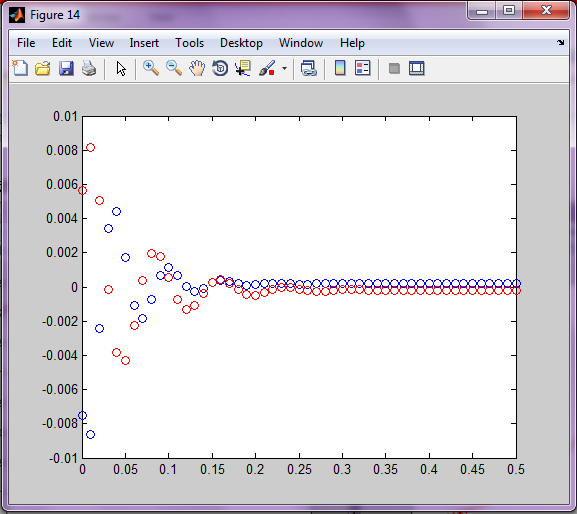
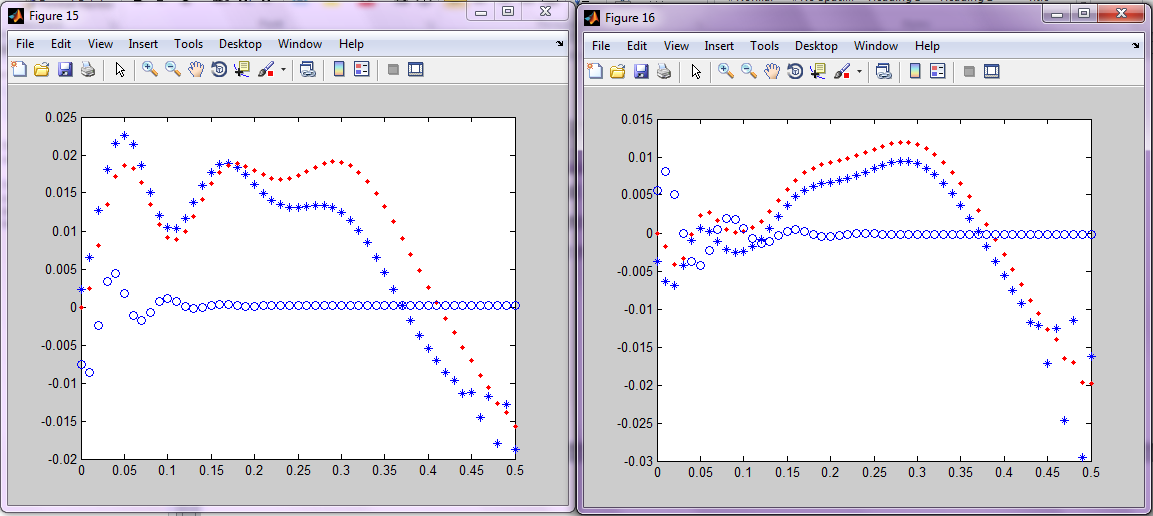


Figure 9. Error of the joint angles

1. Comparing from the result of the controllers:

We compare the result by draw the angles’s error of each jont on the same figure:



1. (b)

Figure 10. Error of the joint angles :a) joint 1, b) joint 2

In both cases. The blue O line is the error of torque compute control method

The blue \* line is the error of PD+gravity control method

The red . line is the error of PD method control method

We can say that the PD control method is not as good as PD+ gravity method

The compute torque control method is better than PD+ gravity method

(Definitely the result show that in the case of no controller, it is the worst case)