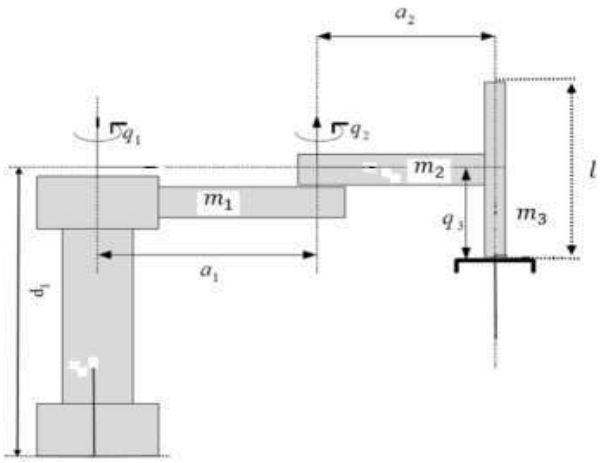
1- you derived work space and dynamic equations (for first three joints)of Scara robot in previous home works (HW3 & HW5)



Now use those equations and design two simulations for desired position for this robot by :

a) Adaptive Inverse Dynamic Method (A.I.D)

b) Adaptive Passivity Based Control Method

use these values:
(for simulation suppose 15% uncertainty)

$$m_1 = 12\,Kg \quad m_2 = 6\,Kg \quad m_3 = 6\,Kg$$
$$I_1 = .36\,Kg.m^2 \quad I_2 = .36\,Kg.m^2$$
$$a_1 = .6\,m \quad a_2 = .4\,m$$
$$l_{c1} = .3\,m \quad l_{c2} = .2\,m$$

2) you can find dynamic equations of RR manipulator in references
The initial position of the robot arm is $q = [\pi/3, -2\pi/3]^T$. The desired trajectory of the robot arm is a minimum jerk motion , which is specified in Cartesian space as:

$X_d = [.2 + .1(6t^5 - 15t^4 + 10t^3)\ ,\ 0]^T \quad for\ t \in [0,1]$

The parameter of target impedance model are:

$$M_d = \begin{bmatrix} 0.1 & 0 \\ 0 & 0.1 \end{bmatrix} \qquad D_d = \begin{bmatrix} 8 & 0 \\ 0 & 8 \end{bmatrix} \qquad K_d = \begin{bmatrix} 0.1 & 0 \\ 0 & 0.1 \end{bmatrix}$$

Do these simulations:
a) There is no contact between the environment and robot arm

b) we assume that there is an interaction force exerted to the end-effector by the environment. The interaction force is with a constant value of $f_x = 0.1$. The force measurement noise is a uniform-random-number signal with amplitude of 0.01.

$m_1 = m_2 = 1\ Kg$

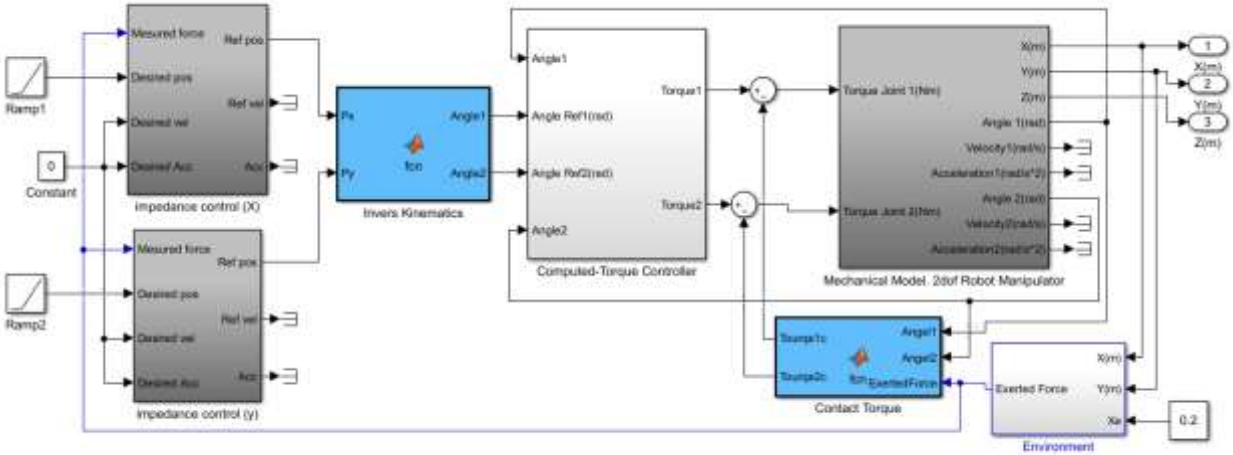
$I_1 = I_2 = .003 Kg.m^2$

$l_1 = l_2 = .2\ m$

$l_{c1} = l_{c2} = .1 m$

One of impedance control application: suppose the robot follows a trajectory and suddenly an object or obstacle is shown on its way, the robot will collide with it, trying to reach the final end position of the given trajectory, and exerting such a huge forces into the environment that would likely cause damages to a real robot or to both the object of collision and robot. To solve this situation and avoid it, an impedance controller will be designed. In fact the output of the controller will be a modified trajectory. That means if the forces are not sensed, the trajectory will be followed accurately. Otherwise when forces are sensed, the trajectory will be modified in order to regulate the maximum forces

For more detail about impedance simulation take a look at diagram below:


Ramp1
Constant
Ramp2
Mesured force
Ref pos
Desired pos
Ref vel
Desired vel
Acc
Desired Acc
impedance control (X)
impedance control (y)
Px
Py
fcn
Angle1
Angle2
Invers Kinematics
Angle Ref1(rad)
Angle Ref2(rad)
Torque1
Torque2
Computed-Torque Controller
Torque Joint 1(Nm)
Torque Joint 2(Nm)
X(m)
Y(m)
Z(m)
Mechanical Model. 2dof Robot Manipulator
Torque1c
Torque2c
ExertedForce
Contact Torque
Exerted Force
Xe
Environment
0.2
1
2
3