EC4.401 Robotics: Dynamics and Control

Assignment 2

Robotics Research Center
International Institute of Information Technology Hyderabad

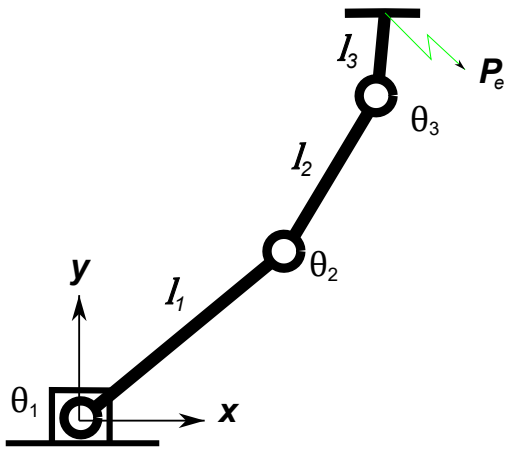
Total Marks : (10)
Due Date : 12-10-2021
Late Submission : Each day after the due date will receive a penalty of 1 mark - deduced from the total marks obtained.

Instructions:
Matlab is preferred for writing the programs.
Students should 1) write the code individually
2) submit the script as well as the document with the program outputs.

Answer all the questions:

1. Using Euler angles ZYX convention parameterize the rotation matrix (2 marks)
   1.1 Find the rotation matrix - Write a function that takes Euler angles as inputs and outputs the corresponding rotation matrix (1)
   1.2 Solve for the angles - Write a function that takes Rotation matrix as input and outputs the corresponding Euler angles (1)

2. Refer to the 3R planar manipulator shown below. (2 marks)
   2.1 Find the end-effector tool position (0.5)
   2.2 Graphically demonstrate the forward kinematics and show the dexterous workspace. For every change in joint angles, show the corresponding configuration graphically. (1.5)



3. We have already discussed the relation between the axis-angle and the rotation matrix in the class. (2.5 marks)

$$\boldsymbol{R} = \left(\mathbf{I} + \sin\theta\hat{\mathbf{n}} + (1 - \cos\theta)\hat{\mathbf{n}}^{\mathbf{2}}\right)$$

   3.1 In continuation with that, find $\boldsymbol{n} = [n_1 \quad n_2 \quad n_3]^{\boldsymbol{T}}$ and θ for a given generalized rotation matrix $\boldsymbol{R} = \begin{bmatrix} r_{11} & r_{12} & r_{13} \\ r_{21} & r_{22} & r_{23} \\ r_{31} & r_{32} & r_{33} \end{bmatrix}$. (1)

3.2 Write a program that takes $\boldsymbol{n}, \theta$ as inputs and returns the corresponding rotation matrix, and vice versa. (1.5)

4. DH representation for a 7DoF manipulator (3.5 marks)

4.1 Find the DH parameters for the robot shown below*. (1)

4.2 Write a function that takes in DH parameters as input and returns the transformation matrix. Using this function, derive the end-effector pose with respect to the base frame. (1.5)

4.3 Validate with the home configuration. (1)