

Introduction to Robotics (CS223A)

(Winter 2011/12)

Review 1

Date January 25, 26

1. (*D-H Parameters*) Consider the PRRR manipulator shown below:

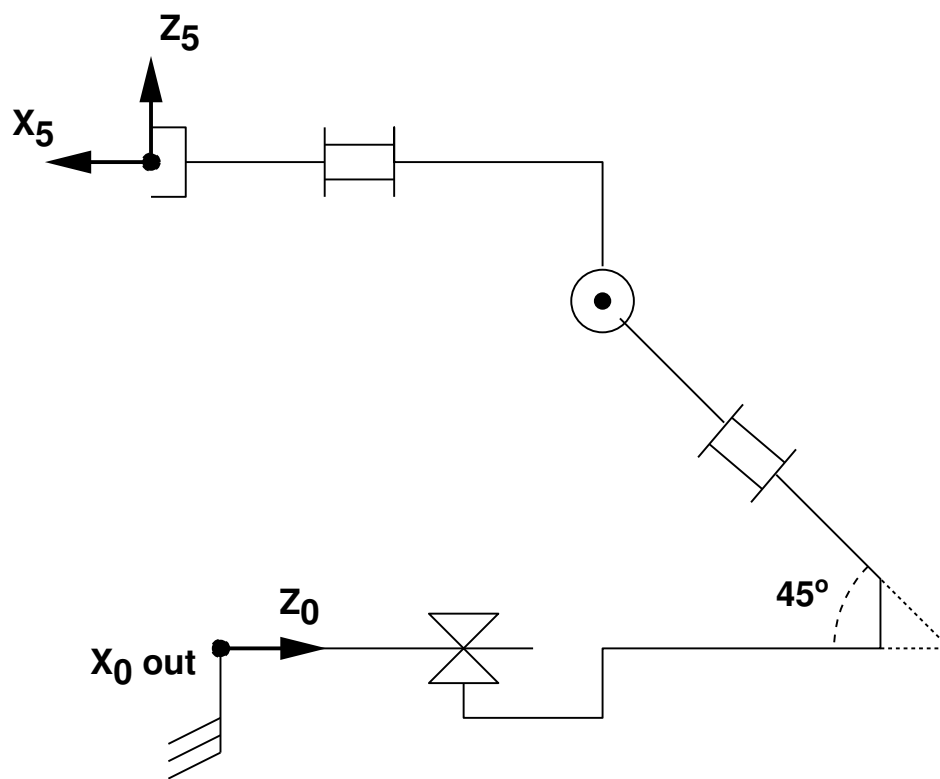


Figure 1: Schematic of an PRRP manipulator.

- (a) Draw the frames $\{1\}$, $\{2\}$, $\{3\}$, and $\{4\}$. Use the conventions studied in class.
- (b) Introduce appropriate D-H parameters where necessary and label them on the figure.

(c) Fill in the table of D-H parameters below:

i	α_{i-1}	a_{i-1}	θ_i	d_i	conf. shown
1					
2					
3					
4					
5					n/a

2. (*Kinematics*)

Examine the following RPP manipulator:

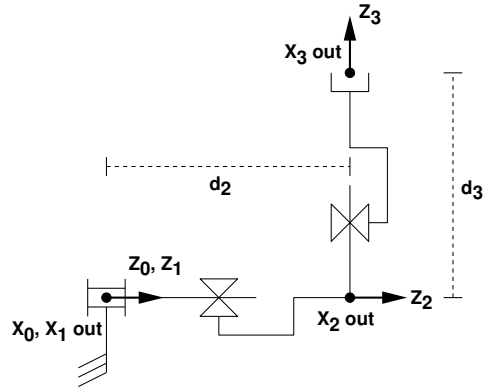


Figure 2: Schematic of an RPP manipulator.

- (a) Given the transformation matrix

$${}^1_3T = \begin{bmatrix} 1 & 0 & 0 & 0 \\ 0 & 0 & -1 & -d_3 \\ 0 & 1 & 0 & d_2 \\ 0 & 0 & 0 & 1 \end{bmatrix}$$

find the forward kinematics matrix 0_3T .

- (b) For the joint angles $\theta_1 = 30^\circ$, $d_2 = 4$, and $d_3 = 6$, what is the location of the end-effector (in Frame $\{0\}$)?

- (c) In contrast to part (b), suppose we know the position of the end-effector:

$${}^0p_E = \begin{bmatrix} 2\sqrt{2} \\ 2\sqrt{2} \\ 5 \end{bmatrix}$$

What are the values of the joint angles θ_1 , d_2 and d_3 for this position? (Assume $d_3 > 0$.)

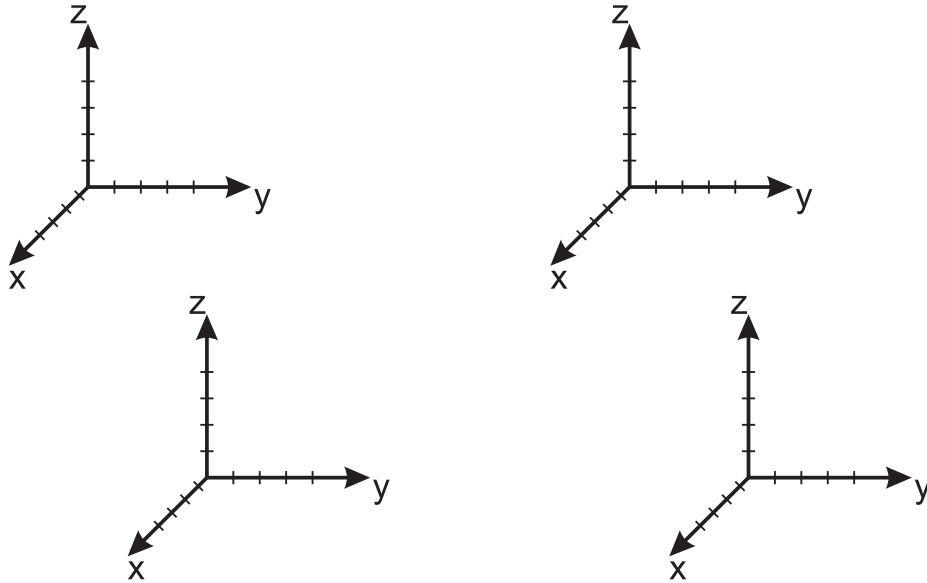
3. (*Rotations*)

Given the following 3x3 matrix,

$$R = \begin{bmatrix} 0 & \frac{1}{\sqrt{2}} & \frac{1}{\sqrt{2}} \\ \frac{1}{\sqrt{2}} & \frac{1}{2} & -\frac{1}{2} \\ -\frac{1}{\sqrt{2}} & \frac{1}{2} & -\frac{1}{2} \end{bmatrix}.$$

- (a) Show that it is a rotation matrix.
- (b) Determine a unit vector that defines this axis of rotation and the angle (in degrees) of rotation.
- (c) What are the Euler parameters $\varepsilon_1, \varepsilon_2, \varepsilon_3, \varepsilon_4$ of R ?

4. (Rotations) $\mathbf{RT}_N = R_y(90)D_z(3)R_x(90)D_y(2)$ (from right to left)



$\mathbf{RT}_N = R_y(90)D_z(3)R_x(90)D_y(2)$ (from left to right)

