Introduction to Robotics

Manipulation and Programming

Unit 2: Kinematics

DISPLACEMENT VECTORS PYTHON PROGRAMMING

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Objective

- Learn how to formulate displacement vector and represent it in Python environment
- Prepare for Programming Assignment: Displacement Vector

Displacement Vector

SECTION 1

Displacement Vector

- A vector is a list of numbers. In robotics, we typically use three numbers (all organized in a single column), to represent displacement (i.e. change in position) of one frame relative to another frame in the x, y, and z directions.
- We'll use the following notation to represent the displacement of coordinate frame n relative to coordinate frame m.

Displacement Vector

The Transition of

$$d_n^m = \begin{bmatrix} d_{xx} \\ d_{yy} \\ d_{zz} \end{bmatrix} \begin{matrix} x_n^m \\ y_n^m \\ z_n^m \end{matrix}$$

Transitional displacement vector from frame n with respective to frame m.

Python Row Vector and Column Vector

Row Vector:

```
d0_1 = [1, 2, 3]
```

Column Vector:

```
d0_1 = [[1],
        [2],
        [3]]
```

Numpy Array Attributes

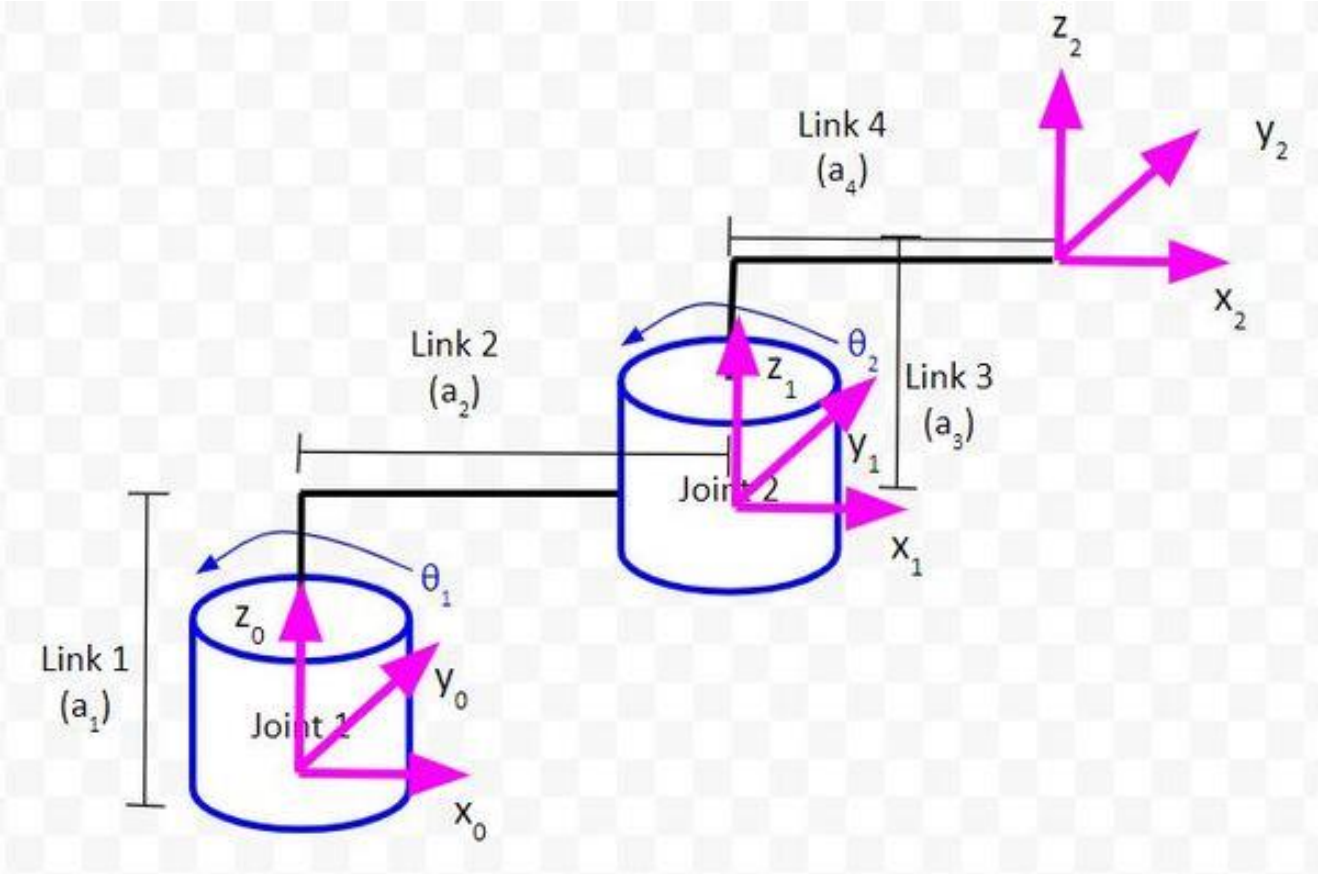
```
>>> import numpy as np
>>> a = np.arange(6)         # NumPy arange returns an array object
>>> a
array([0, 1, 2, 3, 4, 5])
>>> a = a.reshape(2,3)
>>> a
array([[0, 1, 2],
       [3, 4, 5]])
>>> a.shape
(2, 3)                       # note: this returns a tuple
>>> a.ndim
2
>>> a.size
6
```

Numpy Vector

```
d = [[1],
     [2],
     [3]]
d1 = np.matrix(d)
d2 = [1, 2, 3]
d2 = np.array(d2)
d2 = d2.reshape(3, 1)
print(d2)
```

Case Study

SECTION 2



Kinematic Diagram

Displacement Vector

$$d_1^0 = \begin{bmatrix} a_2 \cos(\theta_1) \\ a_2 \sin(\theta_1) \\ a_1 \end{bmatrix} \qquad d_2^1 = \begin{bmatrix} a_4 \cos(\theta_2) \\ a_4 \sin(\theta_2) \\ a_3 \end{bmatrix}$$