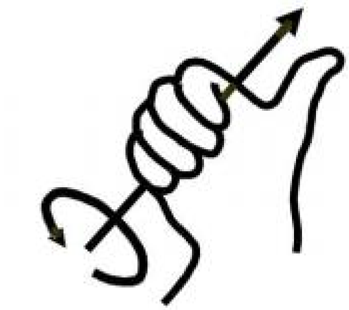
Lesson 1 Establish robotic Arm Coordinate System

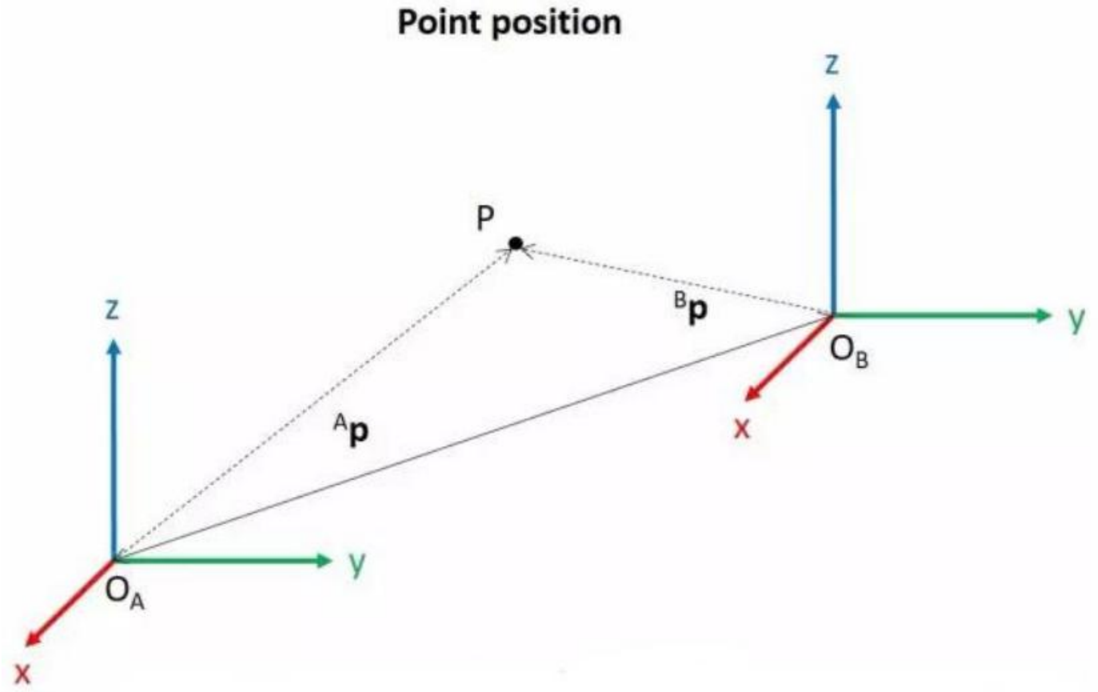
1.Coordinate System Introduction

Most of the descriptions of spatial position, speed and acceleration are in Cartesian coordinate system, which is well known as a coordinate system composed of three mutually perpendicular coordinate axes.When we say how many angles to rotate around a certain axis, the right-hand rule is used to determine the positive direction, as shown below:



2. Position, Translation Swap

The position is represented by a three-dimensional vector, and the translation transformation is the transformation of the coordinate system space position, which can be represented by the position vector of the coordinate system origin O, as shown in the figure below. Multiple translation transformations are also very simple. You can find the coordinates of a point in space in the coordinate system {B} after translation transformation by adding directly between vectors.



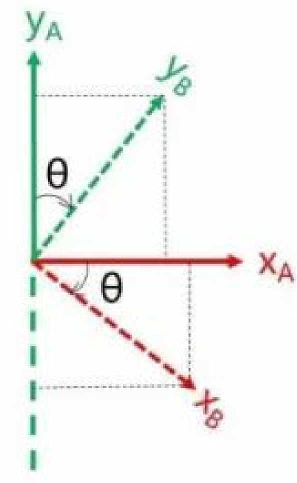
$$^{B}\vec{p} = {}^{A}\vec{p} - {}^{A}\vec{p}_{O_B}$$

$$^{A}\vec{p} = {}^{B}\vec{p} - {}^{B}\vec{p}_{OA}$$

3.Angle/Direction, Rotation Transformation

Compared with the position, the representation method of the bearing is relatively troublesome. Before discussing the bearing , it is necessary to explain one point: the three-dimensional position and orientation of an object are usually "attached" to the object with a coordinate system that moves and rotates with it, and then by describing the coordinate system and the reference coordinate system Relationship to describe this object.

Describing the position and orientation of an object in the coordinate system can be equivalently understood as describing the relationship between the coordinate systems. We talk about angle/direction notation here, as long as we talk about the relationship between two coordinate systems. To know how and how much a coordinate system is rotated relative to another coordinate system, what should be done? Let's start with the two-dimensional situation:



By coordinate axis unit vector with the reference coordinate system expressing, though reference the picture we can directly written the following formula:

$$^A\vec{x}_B = [\begin{matrix}\cos\theta \\ -\sin\theta\end{matrix}]$$

$$^A\vec{y}_B = [\begin{matrix}\sin\theta \\ \cos\theta\end{matrix}]$$

We define a 2x2 matrix:

$$^A_BR = [\,^A\vec{x}_B \quad ^A\vec{y}_B] = [\begin{matrix}\cos\theta & \sin\theta \\ -\sin\theta & \cos\theta\end{matrix}]$$

Obviously, each column of this matrix is the representation of the coordinate axis unit vector of coordinate system B in the coordinate system. With this matrix, we can draw the x-axis and y-axis of coordinate system B and determine the unique orientation of B.

4. Rotation Matrix

The three-dimensional orientation of space is relatively more complicated, because the orientation of the coordinates on the plane can only have one degree of freedom, that is, to rotate around the axis of the vertical plane. The orientation of objects in space will have three degrees of freedom. However, if we start from the first method in the figure above, we can easily write a 3×3 R matrix, which we call the rotation matrix:

$${}^{A}_{B}R = \begin{bmatrix} {}^{A}\vec{x}_{B} & {}^{A}\vec{y}_{B} & {}^{A}\vec{z}_{B} \end{bmatrix}$$

This formula shows that in the rotation matrix from the coordinate system {B} to the coordinate system {A}, each column is the representation of the coordinate axis unit vector of the coordinate system {B} in the coordinate system {A}.