2.1 Relative Pose & Translation

Centre for Autonomous Systems
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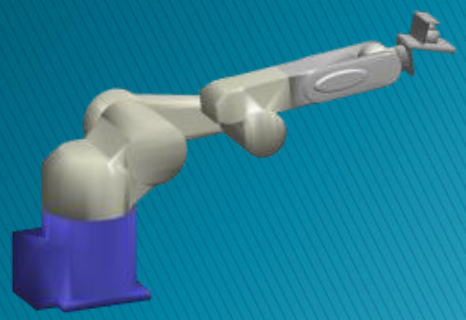
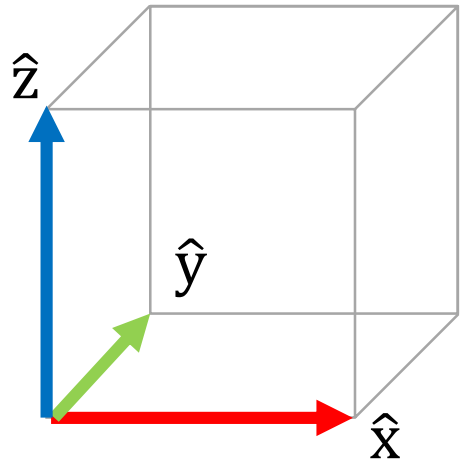
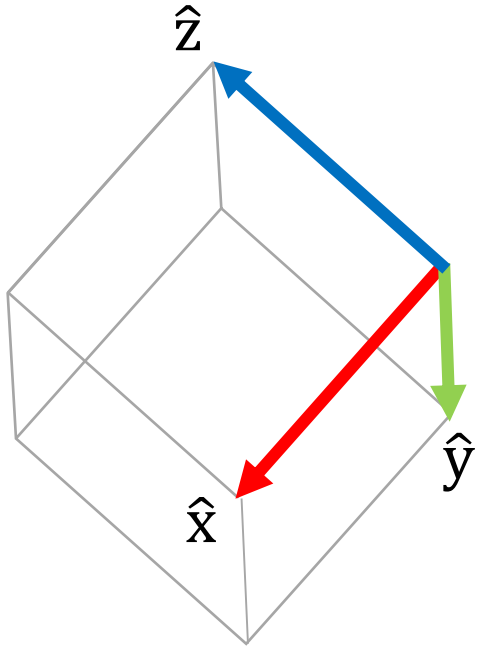


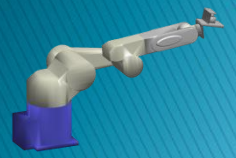
Reference Frames

- Position and orientation in space is relative
- We need both to fully describe 3D space



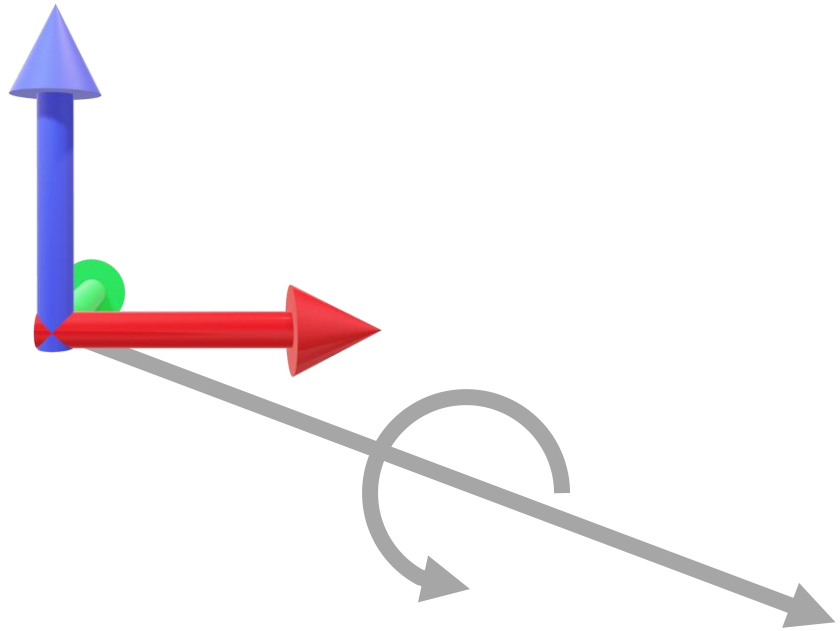


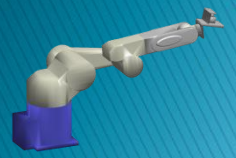
$$\text{Pose} = \text{Position} + \text{Orientation}$$



Transforming Between Reference Frames

- Moving between reference frames involves both a **translation** and **rotation**





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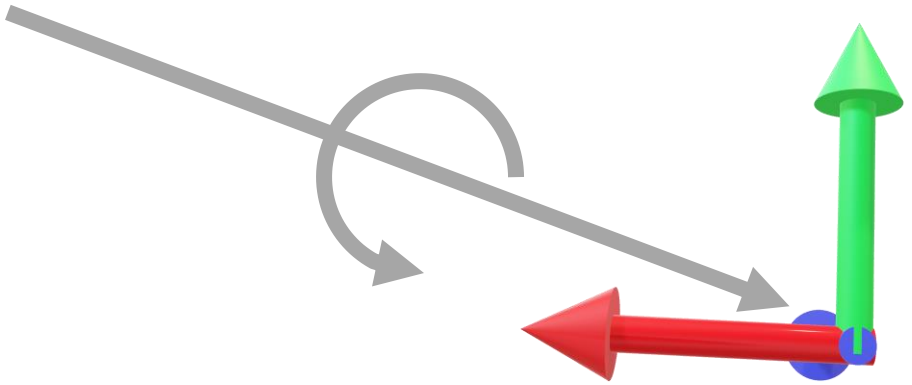
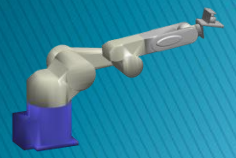




Position and Translation In A Common Reference Frame

Two points in 3D Euclidean space:

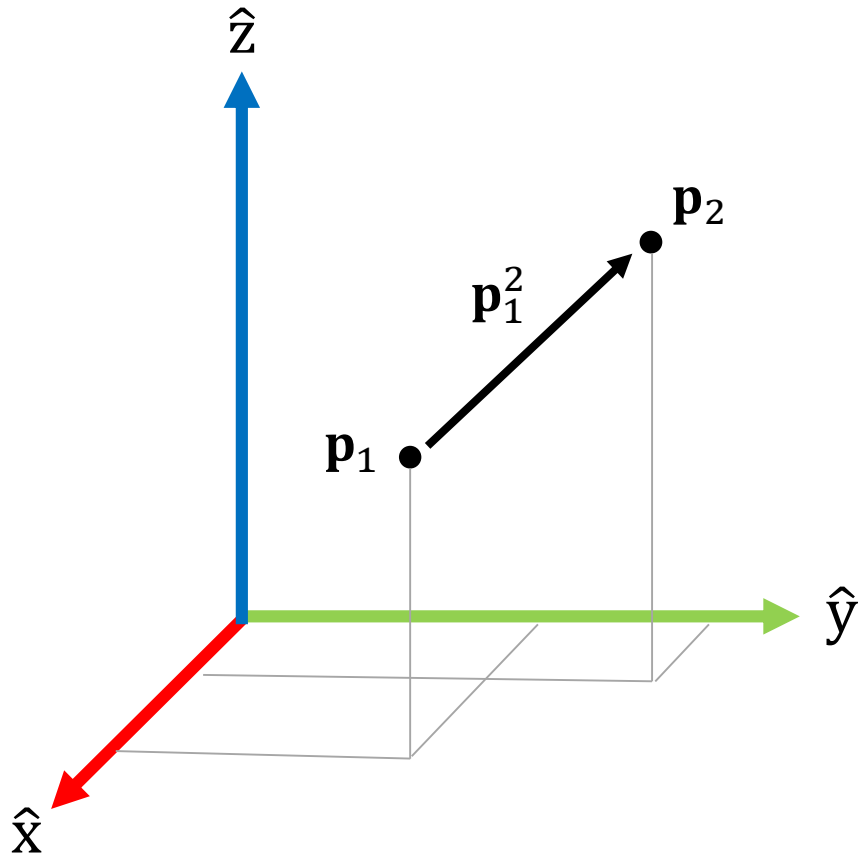
$$\mathbf{p}_1 = \begin{bmatrix} x_1 \\ y_1 \\ z_1 \end{bmatrix} \in \mathbb{R}^3$$

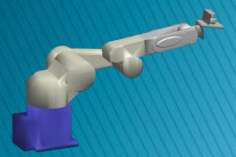
$$\mathbf{p}_2 = \begin{bmatrix} x_2 \\ y_2 \\ z_2 \end{bmatrix} \in \mathbb{R}^3$$

Translation between points:

$$\mathbf{p}_1^2 = \mathbf{p}_2 - \mathbf{p}_1$$

$$= \begin{bmatrix} x_2 - x_1 \\ y_2 - y_1 \\ z_2 - z_1 \end{bmatrix} \in \mathbb{R}^3$$





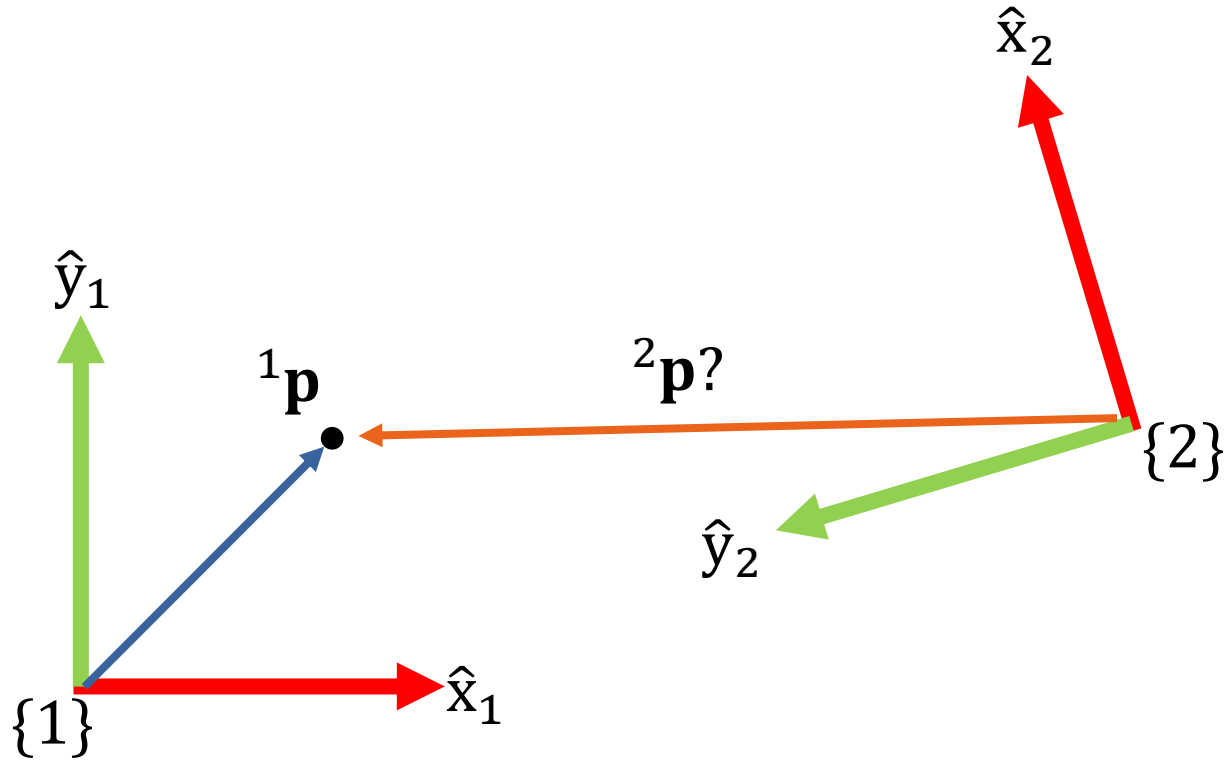
Position and Translation In Different Reference Frames

Two reference frames with different **position** and **orientation** (pose).

Point in frame {1} ${}^{1}\mathbf{p}$.

What is the distance from frame {2} to the point ${}^{2}\mathbf{p}$?

Need to consider the relative **orientation** between reference frames.



Summary of Relative Pose & Translation

Pose = Position + Orientation

$$\mathbf{p} = \begin{bmatrix} x \\ y \\ z \end{bmatrix} \in \mathbb{R}^3$$

A point in 3D Euclidean space

$$\mathbf{p}_1^2 = \begin{bmatrix} x_2 - x_1 \\ y_2 - y_1 \\ z_2 - z_1 \end{bmatrix} \in \mathbb{R}^3$$

Translation between two points in the **same reference frame**

$${}^1\mathbf{p} \rightarrow {}^2\mathbf{p}$$

Two describe translation in **different reference frames**, relative orientation must be considered.