(3)

Basic Pick & Place (Part 1)

* Step 1: Kinematic Frames / Spatial Algebra
* Step 2: Gripper Frame Plan "sketch"
* Step 3: Forward Kinematics of the iiwa + WSG

★ Kinematic Frames / Spatial Algebra

p^A → position of A {A is a point or frame}

↳ But it is always relative to another position.

${}^B p^A$ → Position of A relative to point B

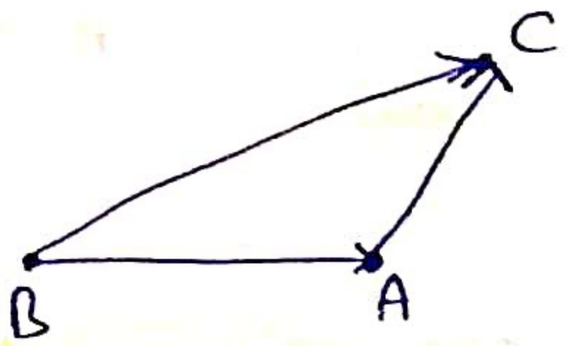
${}^B p^A_C$ → Position of A relative to B expressed in some frame C.

{Position + Orientation}

{Represented by notation}

Positions add

$$ {}^B p_C^A + {}^A p_C^E = {}^B p_C^E $$



Additive Inverse

$$ -{}^B p_C^A = {}^A p_C^B $$

${}^B R^A$ → Orientation of A in B

{Represented by rotation}

Representation

- Rotation Matrix
- Quaternion
- Axis Angle
- Roll Pitch Yaw (Euler Angles)

⊛ Rotations multiply

$$^{B}R^{A}\,{}^{A}R^{C} = {}^{B}R^{C}$$

⊛ Multiplicative inverse

$$\left({}^{B}R^{A}\right)^{-1} = {}^{A}R^{B}$$

POSE → Position and Orientation of a frame Combined.

- *No one representation works for all situation.
- * Depending on situation You choose different Representation

${}^{B}X^{A}$ → Pose of A in B

Transform → Translation and Rotation

$${}^{A}X^{B}\,{}^{B}X^{C} = {}^{A}X^{C}$$

$$\left({}^{A}X^{B}\right)^{-1} = {}^{B}X^{A}$$

$${}^{D}p_{C}^{A} = {}^{C}R^{D}\,{}^{B}p_{p}^{A}$$

★ Important Frame

W → World frame

$R^{D} = {}^{W}R^{D}$ {If frame is not specified, it is world frame}

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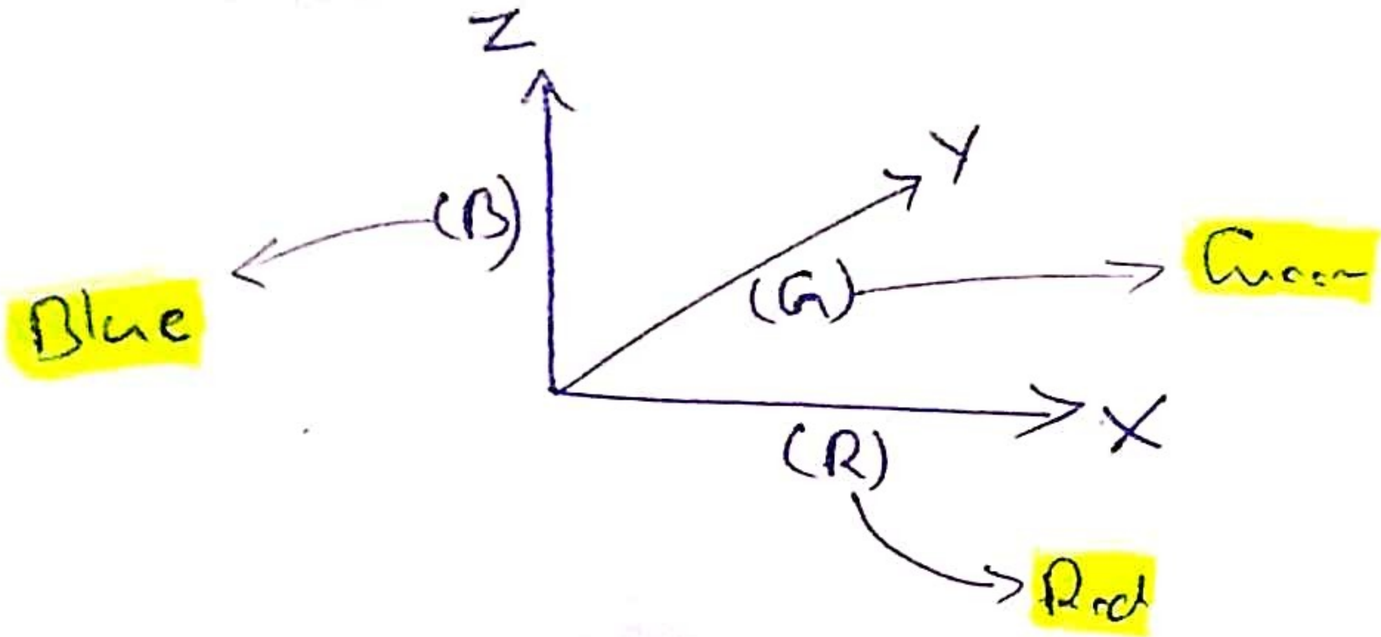
Similar for position,

$$P^B = {}^W P^B_W \qquad {}^A P^B = {}^A P^B_A$$



Quaternion Slerp

→ Spherical linear Interpolation

★ Forward Kinematics

$$X^B = f_{kin}^B(q)$$

- X^B → Pose of end Effector
- q → Joint Coordinate

Inverse Kinematics

↳ Given the joint coordinate find Pose of End-effector.

Differential Kinematics

↳ $\frac{\delta f_{Kin}}{\delta q}$

Joints

↳ It gives (Adds) Constraints between two bodies.

Revolute Joint

Prismatic Joint

Kinematic Tree