MAIN PARTS: Joins & Links

- Processor
- Controller (motors)
- End-Effectors: MEC, Grippers, Vacuum, etc.
- Sensors: Encoders, Tactile, Force, Vision
- Actuators: Stepper Motors, Pneumatic, Hydraulic

Robot Components

- Type A - D
- AFF
- PCI
- JRA

What is a Robot?
Figure 1.7 Typical Workspaces for common robot configurations:

- Articulated (AR)
- Spherical (SP)
- Cylindrical (CP)
- Cartesian (CR)

Types of Joints & Axes

- Rotary or Revolute (R)
- Linear or Prismatic (P)
(Microcosm) Environment

Repetitiveness

Precision

Reach

Payload: (ps. weight)
To achieve a 3DOF at its end-effector, a robot must have at least 3 joints (end-effectors).

Note: # Joints = # DOF (End-effectors)

Figure 1.5: Coordinate systems of "frames" are attached to the manipulator and to objects in the environment.

Degrees of Freedom
Pump: VAL 3 VAL 2

Invariance: AS Language

Sentence

Supervise (get - link & simulation)

Walk - Troubleshoot

Reach More

Physical Setup

More

+ Recognition
Configuration of these joints.

A robot - DOF's - what is true

And the definition of joints/links of

Inverse given the pose of the end-effector frame.

(End) frame?

Given a pose of the joint angles (and links)

What is the pose of the End.

Forward given a set of joint angles (and links)

Two questions may be addressed:

Kinematics Robot
Figure 1.7: Typical workspaces for common robot configurations.
\[
\begin{pmatrix}
1 & 0 & 0 & 0 \\
0 & 1 & 0 & 0 \\
0 & 0 & 1 & 0 \\
0 & 0 & 0 & 1 \\
\end{pmatrix}
\] =

From \((x, y, z)\) in \text{cart.}

\[
(3p)
\]

\underline{F.K. or a Cartesian Reason}
\[
\begin{bmatrix}
1 & 0 & 0 \\
0 & 1 & 0 \\
0 & 0 & 1
\end{bmatrix}
\begin{bmatrix}
\frac{1}{2} & 0 & 0 \\
0 & \cos \theta & \sin \theta \\
0 & -\sin \theta & \cos \theta
\end{bmatrix}
= \begin{bmatrix}
0 & \sin \theta & \cos \theta \\
-\sin \theta & \cos \theta & 0 \\
\cos \theta & 0 & 0
\end{bmatrix}
\]

\[\mathbf{y}_e = (r', z') = (r, 0, 0) + (0, \theta, 0)\]

\[\mathbf{y}_c = (r, \theta, z)\]

\[\text{E.K. or cylindrical robot}\]

**Figure 2.23: Cylindrical coordinates.**
\[
\begin{bmatrix}
1 & 0 & 0 & 0 \\
0 & 1 & 0 & 0 \\
0 & 0 & C_x & C_y \\
0 & 0 & -S_x & S_y
\end{bmatrix}
\begin{bmatrix}
1 & 0 & 0 & 0 \\
0 & 1 & 0 & 0 \\
0 & 0 & C_x & C_y \\
0 & 0 & -S_x & S_y
\end{bmatrix}
= \begin{bmatrix}
1 & 0 & 0 & 0 \\
0 & 1 & 0 & 0 \\
0 & 0 & C_x & C_y \\
0 & 0 & -S_x & S_y
\end{bmatrix}
\begin{bmatrix}
1 & 0 & 0 & 0 \\
0 & 1 & 0 & 0 \\
0 & 0 & C_x & C_y \\
0 & 0 & -S_x & S_y
\end{bmatrix}
\]

\[
\Delta \text{SR} (r', \theta') = \Delta \text{SR} (r, \theta)
\]

\[
\text{F} \cdot \text{K} \text{ of a \ Special \ Robo}
\]
\[
T = 5
\]

\[
\text{why not } \theta = 23^\circ \]

\[
\frac{\tan \theta}{\tan 30^\circ} = \frac{\tan 30^\circ}{\tan \theta} = 3\]

\[
F = \frac{15}{\theta} \quad \text{and} \quad F \cdot \cos \theta = 3 \cdot \frac{15}{\theta} \quad \text{RSE} = 3
\]

\[
\begin{bmatrix}
1 \\
4 \\
7 \\
3
\end{bmatrix}
\]

\[
\begin{bmatrix}
\frac{1}{2} & 0 & 0 \\
0 & 0 & 0 \\
0 & 0 & 0
\end{bmatrix}
\]

\[
\begin{bmatrix}
1 & 0 & 0 \\
0 & 0 & 1 \\
0 & -1 \theta & 0
\end{bmatrix}
\]

\[
\text{KINEMATICS?}
\]

\[
\text{IS THIS AN INVERSE OR FORMULATION?}
\]

\[
\text{The necessary joint configuration?}
\]

\[
\begin{bmatrix}
7 \\
4 \\
3
\end{bmatrix}
\]

\[
\text{what is a clyl. nobsol to move blue e.}\]

\[
\text{we want to move one blue cylinder}
\]

\[
\text{EX}
\]
\[ \tan \alpha = \frac{3}{4} \Rightarrow \alpha = 53.13^\circ \]

\[ \cos \alpha = \frac{4}{5} \]

\[ \text{CP} = 7 \]

\[ \text{SP} \text{CA} = 3 \]

\[ \Rightarrow \text{SP} \text{CA} = 3 \]

\[ \begin{bmatrix}
1 & 0 & 0 & 0 \\
0 & 1 & 0 & 0 \\
0 & 0 & 1 & 0 \\
-5p & -5p \cdot \text{CA} & -5p \cdot \text{CA} & 15p \cdot \text{CA}
\end{bmatrix} = \]

\[ \text{Same for subsequent parts} \]
Which one is convex?

\[ p = -35.5 \]
\[ r = 8.6 \]
\[ r \leq p \Rightarrow \text{convex} \]
\[ 5.8 \times 0.8 = 4 \]
\[ 1.5 \times 0.6 = 3 \]
\[ 5.8 \times 0.8 = 4 \]
\[ 1.5 \times 0.6 = 3 \]
\[ \text{or} \]
\[ \text{or} \]
\[ 5 \times 0.8 = 4 \]
\[ 6 \times 0.6 = 3 \]
\[ \text{or} \]
\[ \text{or} \]
\[ 5 \times 0.8 = 4 \]
\[ 6 \times 0.6 = 3 \]