

Supplementary Details on Inverse Kinematics

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- t_0 is just the coordinates of joint 0 in the world reference frame.
- For $i > 0$, $t_i = \begin{pmatrix} l_i \\ 0 \\ 0 \end{pmatrix}$ where l_i is the length of the i -th bone.
- To compute the axis-angle parameters ω_i , denote the unit vectors of bone i and $i + 1$ as u, v respectively. Bone 0 is $\hat{x} = \begin{pmatrix} 1 \\ 0 \\ 0 \end{pmatrix}$. The axis-angle parameters aligning the x-axis of reference frames from joint i to joint $i + 1$ is given by $\frac{u \times v}{\|u \times v\|} \arccos(u \cdot v)$.
- Hint: Do this in reverse fashion, i.e. start by finding the parameters for aligning the last bone.

Supplementary Details on Forward Kinematics

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- Given $\xi = \begin{pmatrix} \omega \\ t \end{pmatrix} \in \mathfrak{se}(3)$, the $SE(3)$ matrix representation is

$$e^\xi \equiv \begin{pmatrix} R(\omega) & T \\ 0 & 1 \end{pmatrix}$$

where $R(\omega)$ is given in [the axis-angle representation](#).

- The 3D coordinates of joint i in the world reference frame is simply given by the first 3 entries in

$$e^{\xi_0} e^{\xi_1} \dots e^{\xi_i} \begin{pmatrix} 0 \\ 0 \\ 0 \\ 1 \end{pmatrix}.$$

- Why?