

DoNR

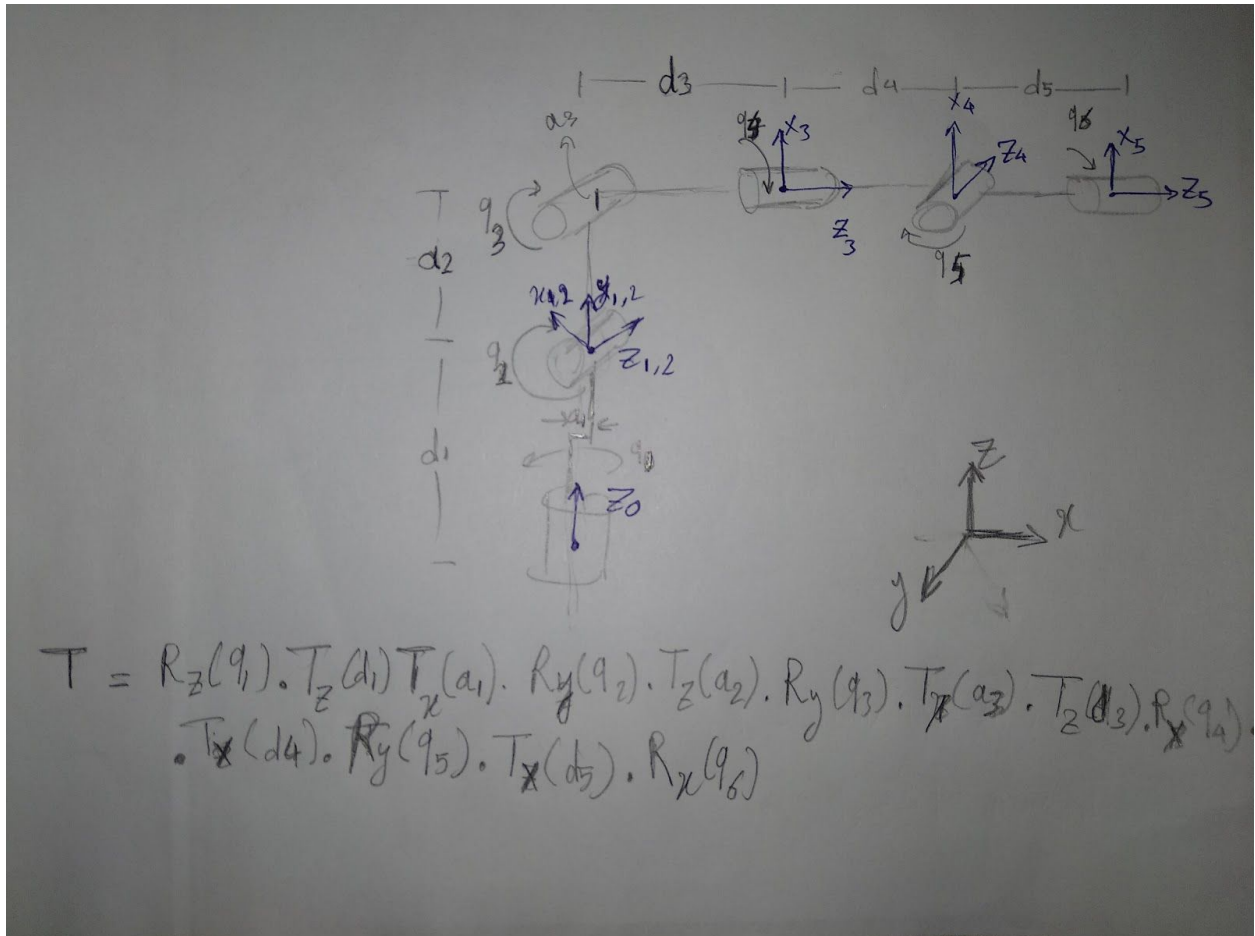
DoNR HW02

Forward and Inverse Kinematics of Kuka KR 10 R11000-2

Github link: <https://github.com/mhd-medfa/Kuka-KR-10-Forward-and-Inverse-Kinematics>



Forward Kinematics:



A diagram showing a beam element in a coordinate system. The vertical axis is labeled y_0 and the horizontal axis is labeled x_0 . The beam is oriented at an angle q_1 to the vertical axis. The beam's end points are labeled y_c and x_c . A point P_c is marked on the beam.

$q_1 = \arctan 2(y_c, x_c) \dots \frac{1}{2}$; $x_c = y_c = 0$ is a singularity point

A diagram of a three-phase transmission line. The vertical axis is labeled Z_0 and the horizontal axis is labeled Z_c . A bucket is shown on the ground at the origin. The line consists of three conductors labeled q_1 , q_2 , and q_3 . The distance from the ground to the conductors is d_1 . The horizontal distance between the conductors is l . The angle between the conductors is ψ . The distance from the ground to the conductors is d_1 . The distance from the ground to the conductors is d_1 . The distance from the ground to the conductors is d_1 .

$$\psi = 180^\circ - \alpha'_3$$

$$\Delta q = a \tan 2(d_4, d_3) \quad \text{--- (2)}$$

$$\cos \psi = \frac{a_2^2 + a_3^2 - b^2 - l^2}{2 \cdot 2 \cdot h \cdot l} = A \quad (*)$$

$$\psi = \arctan_2(\pm \sqrt{1-A^2}, A)$$

$$q_3 = 180^\circ - \psi - \Delta\varphi$$

Since $q_2 = \varphi_1 + \varphi_2$

let's find φ_1 :

$$\frac{\sin \varphi_1}{a_3'} = \frac{\sin \psi}{\sqrt{l^2 + h^2}}$$

$$\Rightarrow \sin \varphi_1 = \frac{a_3' \cdot \sin \psi}{\sqrt{l^2 + h^2}} \quad \text{Since } \sin \psi = \sin(\pi - q_3') = \sin(q_3')$$

$$= \frac{\tan(q_3') \cdot \cos(q_3') \cdot a_3'}{\sqrt{l^2 + h^2}}$$

$$= \frac{\sqrt{1-B^2}}{B} \cdot B \cdot \frac{a_3'}{\sqrt{l^2 + h^2}}$$

$$\sin \varphi_1 = \sqrt{1-B^2} \cdot \frac{a_3'}{\sqrt{l^2 + h^2}} = B$$

$$\varphi_1 = \text{atan2}(B, \pm \sqrt{1-B^2})$$

$$\varphi_2 = \text{atan2}(h, l)$$

$$q_2 = \varphi_1 + \varphi_2 = \text{atan2}(B, \pm \sqrt{1-B^2}) + \text{atan2}(h, l) \quad \text{④}$$

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if abs(T345_bis[2,2]) != 1:
    q3 = arctan2(np.float(T345_bis[0,2]), -np.float(T345_bis[1,2]))
    q5 = arctan2(np.float(T345_bis[2,0]), np.float(T345_bis[2,0]))
    q4 = arctan2(np.sqrt(np.float(T345_bis[0,2])**2 + np.float(T345_bis[1,2])**2), np.float(T345_bis[2,2]))
else:
    print("Singularity case")

```

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# Solution 2
You, a minute ago • Uncommitted changes
if abs(T345_bis[2,2]) != 1:
    q3 = arctan2(-np.float(T345_bis[0,2]), np.float(T345_bis[1,2]))
    q5 = arctan2(-np.float(T345_bis[2,0]), -np.float(T345_bis[2,0]))
    q4 = arctan2(-np.sqrt(np.float(T345_bis[0,2])**2 + np.float(T345_bis[1,2])**2), np.float(T345_bis[2,2]))
else:
    print("Singularity case")

```

Let's discuss how many solutions we have from IK:

First we notice that we have two solutions for q_1 :

$$q_1 = \text{atan2}(y_c, x_c)$$

Or

$$q_1 = \pi + \text{atan2}(y_c, x_c)$$

For each case of q_1 we have two solutions for q_2 and q_3 (Elbow up & Elbow down) that we studied in the case of the planar robot.

So far we have 2x2 solutions.

Now we have the wrist which gave us two solutions as well:

$$\text{When } q_4 = \text{atan2}(y, x)$$

$$\Rightarrow q_5 = 0$$

Or

$$q_4 = \pi + \text{atan2}(y, x)$$

$$\Rightarrow q_5 = -0$$