

My Karpled Sduff for ze ropodica armz brochect

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1 Raw Python

1.1 The Torques Applied onto the Wrist Joint

```
Tr_W = (M_W * 9.81) * L_W
```

!!Need To Redo/Update!!

1.2 The Torques Applied onto the Elbow Joint

```
Tr_E = ((M_W * 9.81) * (math.sqrt(L_W^2 + L_E^2 - ((2) * (L_W) * (L_E)) * (math.cos(A_W)))))) + ((M_E * 9.81) * L_E)
```

!!Need To Redo/Update!!

1.3 The Torques Applied onto the Shoulder Joint

```
Tr_S = (M_W * 9.81) * (math.sqrt((math.sqrt(L_W^2 + L_E^2 - ((2) * (L_W) * (L_E)) * (math.cos(A_W))))^2 + L_S^2 - ((2) * ((math.sqrt(L_W^2 + L_E^2 - ((2) * (L_W) * (L_E)) * (math.cos(A_W)))) * (L_S)) * (math.cos((A_E - (math.acos(((math.sqrt(L_W^2 + L_E^2 - ((2) * (L_W) * (L_E)) * (math.cos(A_W))))^2 + L_E^2 - L_W^2) / ((2) * (math.sqrt(L_W^2 + L_E^2 - ((2) * (L_W) * (L_E)) * (math.cos(A_W)))) * (L_E)))))))))) + ((M_E * 9.81) * (math.sqrt(L_E^2 + L_S^2 - ((2) * (L_E) * (L_S)) * (math.cos(A_E)))))) + ((M_S * 9.81) * L_S)
```

!!Need To Redo/Update!!

2 Formulae

2.1 The Torques Applied onto the Wrist Joint

$$Tr_W = (9.81 \times M_W) \times \left(\frac{L_W}{2}\right) \quad (1)$$

2.2 The Torques Applied onto the Elbow Joint

$$Tr_E = ((9.81 \times M_W) \times \left(\frac{((\sqrt{L_W^2 + L_E^2 - (2 \times L_W \times L_E \times \cos(A_W))}) - L_E)}{2} + L_E\right)) + ((9.81 \times M_E) \times \left(\frac{L_E}{2}\right)) \quad (2)$$

2.3 The Torques Applied onto the Shoulder Joint

$$Tr_S = ((9.81 \times M_W) \times ((\frac{R_{WS} - R_{ES}}{2}) + R_{ES})) + ((9.81 \times M_E) \times ((\frac{R_{ES} - L_S}{2}) + R_{WE})) + ((9.81 \times M_S) \times (\frac{L_S}{2})) \quad (3)$$

$$R_{WS} = \sqrt{R_{WE}^2 + L_S^2 - (2 \times R_{WE} \times L_S \times \cos(A_{E2}))} \quad (4)$$

$$R_{WE} = \sqrt{L_W^2 + L_E^2 - (2 \times L_W \times L_E \times \cos(A_W))} \quad (5)$$

$$R_{ES} = \sqrt{L_S^2 + L_E^2 - (2 \times L_S \times L_E \times \cos(A_E))} \quad (6)$$

$$A_{E1} = \cos^{-1}(\frac{R_{WE}^2 + L_E^2 - L_W^2}{2 \times R_{WE} \times L_E}) \quad (7)$$

$$A_{E2} = A_E - A_{E1} \quad (8)$$

3 Inverse Kinematics for Robotic Arm

3.1 Inverse Kinematics Modelling in Octave

Lengths:

$$\begin{aligned} L1 &= 10 \text{ Length Of First Arm} \\ L2 &= 7 \text{ Length of Second arm} \\ L3 &= 4 \text{ Length of Third arm} \end{aligned}$$

All possible θ values:

$$\begin{aligned} \theta1 &= 0 : 0.1 : \pi \text{ all possible theta1 values} \\ \theta2 &= 0 : 0.1 : 1.5 * \pi \text{ all possible theta2 values} \\ \theta3 &= 0 : 0.1 : \pi/2 \text{ all possible theta3 values} \end{aligned}$$

Meshgrid:

$$\begin{aligned} [\theta1, \theta2, \theta3] &= \text{meshgrid} \\ (\theta1, \theta2, \theta3) &\text{ generate grid of angle values} \end{aligned}$$

Compute Coordinates:

$$\begin{aligned} X &= l1 * \cos(\theta1) + l2 * \cos(\theta1 + \theta2) + l3 * \cos(\theta1 + \theta2 + \theta3) \text{ compute } x \text{ coordinates} \\ Y &= l1 * \sin(\theta1) + l2 * \sin(\theta1 + \theta2) + l3 * \sin(\theta1 + \theta2 + \theta3) \text{ compute } y \text{ coordinates} \end{aligned}$$

Create datasets:

$$\begin{aligned} \text{data 1} &= [X(:) Y(:) \theta1(:)] \text{ create } x\text{-}y\text{-}\theta1 \text{ dataset} \\ \text{data 2} &= [X(:) Y(:) \theta2(:)] \text{ create } x\text{-}y\text{-}\theta2 \text{ dataset} \\ \text{data 3} &= [X(:) Y(:) \theta3(:)] \text{ create } x\text{-}y\text{-}\theta3 \text{ dataset} \end{aligned}$$

Plot:

$$\text{plot}(X(:), Y(:), 'r.')$$

Figure 1: $X - Y$ coordinates for all θ_1 , θ_2 , and θ_3 combinations

