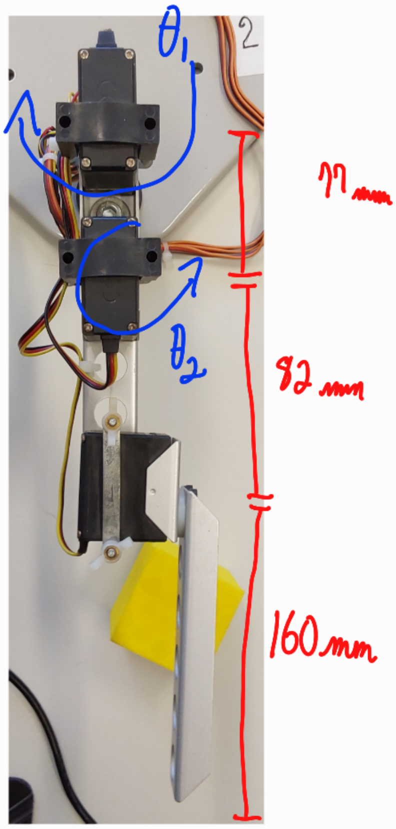
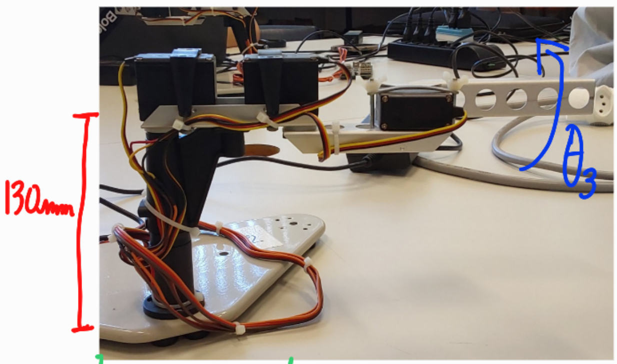
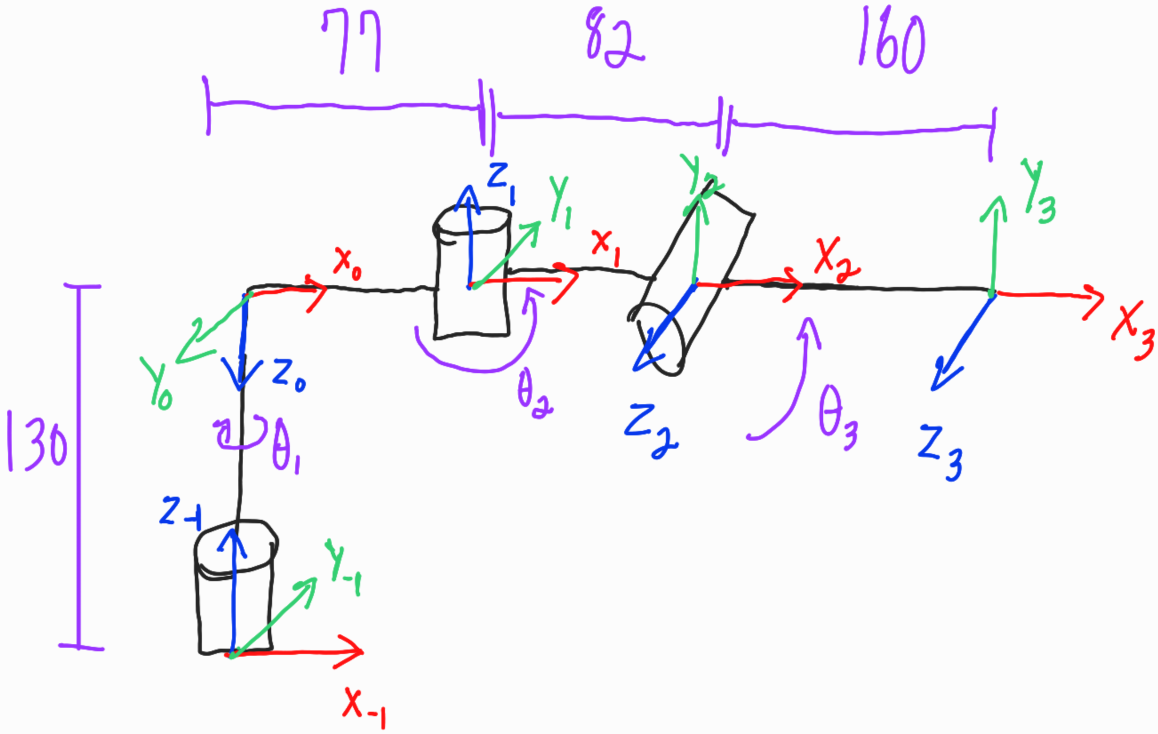




↳ medido da mesa!



i	θ	d	a	α
0	0	130	0	180°
1	θ_1^*	0	77	180°
2	θ_2^*	0	82	90°
3	θ_3^*	0	160	0°

$$A_0 = \begin{bmatrix} 1 & 0 & 0 & 0 \\ 0 & -1 & 0 & 0 \\ 0 & 0 & -1 & 130 \\ 0 & 0 & 0 & 1 \end{bmatrix}$$

$$A_1 = \begin{bmatrix} C_1 & S_1 & 0 & 77C_1 \\ S_1 & -C_1 & 0 & 77S_1 \\ 0 & 0 & -1 & 0 \\ 0 & 0 & 0 & 1 \end{bmatrix}$$

$$A_2 = \begin{bmatrix} C_2 & 0 & S_2 & 82C_2 \\ S_2 & 0 & -C_2 & 82S_2 \\ 0 & 1 & 0 & 0 \\ 0 & 0 & 0 & 1 \end{bmatrix}$$

$$A_3 = \begin{bmatrix} C_3 & -S_3 & 0 & 160C_3 \\ S_3 & C_3 & 0 & 160S_3 \\ 0 & 0 & 1 & 0 \\ 0 & 0 & 0 & 1 \end{bmatrix}$$

$$H_1^{-1} = \begin{bmatrix} 1 & 0 & 0 & 0 \\ 0 & -1 & 0 & 0 \\ 0 & 0 & -1 & 130 \\ 0 & 0 & 0 & 1 \end{bmatrix} \cdot \begin{bmatrix} C_1 & S_1 & 0 & 77C_1 \\ S_1 & -C_1 & 0 & 77S_1 \\ 0 & 0 & -1 & 0 \\ 0 & 0 & 0 & 1 \end{bmatrix} =$$

$$H_1^{-1} = \begin{bmatrix} C_1 & S_1 & 0 & 77C_1 \\ -S_1 & C_1 & 0 & -77S_1 \\ 0 & 0 & 1 & 130 \\ 0 & 0 & 0 & 1 \end{bmatrix}$$

$$H_2^{-1} = \begin{bmatrix} C_1 & S_1 & 0 & 77C_1 \\ -S_1 & C_1 & 0 & -77S_1 \\ 0 & 0 & 1 & 130 \\ 0 & 0 & 0 & 1 \end{bmatrix} \cdot \begin{bmatrix} C_2 & 0 & S_2 & 82C_2 \\ S_2 & 0 & -C_2 & 82S_2 \\ 0 & 1 & 0 & 0 \\ 0 & 0 & 0 & 1 \end{bmatrix}$$

$$H_2^{-1} = \begin{bmatrix} C_1C_2 + S_1S_2 & 0 & C_1S_2 - S_1C_2 & 82C_1C_2 + 82S_1S_2 + 77C_1 \\ -S_1C_2 + C_1S_2 & 0 & -S_1S_2 - C_1C_2 & -82S_1C_2 + 82C_1S_2 - 77S_1 \\ 0 & 1 & 0 & 130 \\ 0 & 0 & 0 & 1 \end{bmatrix}$$

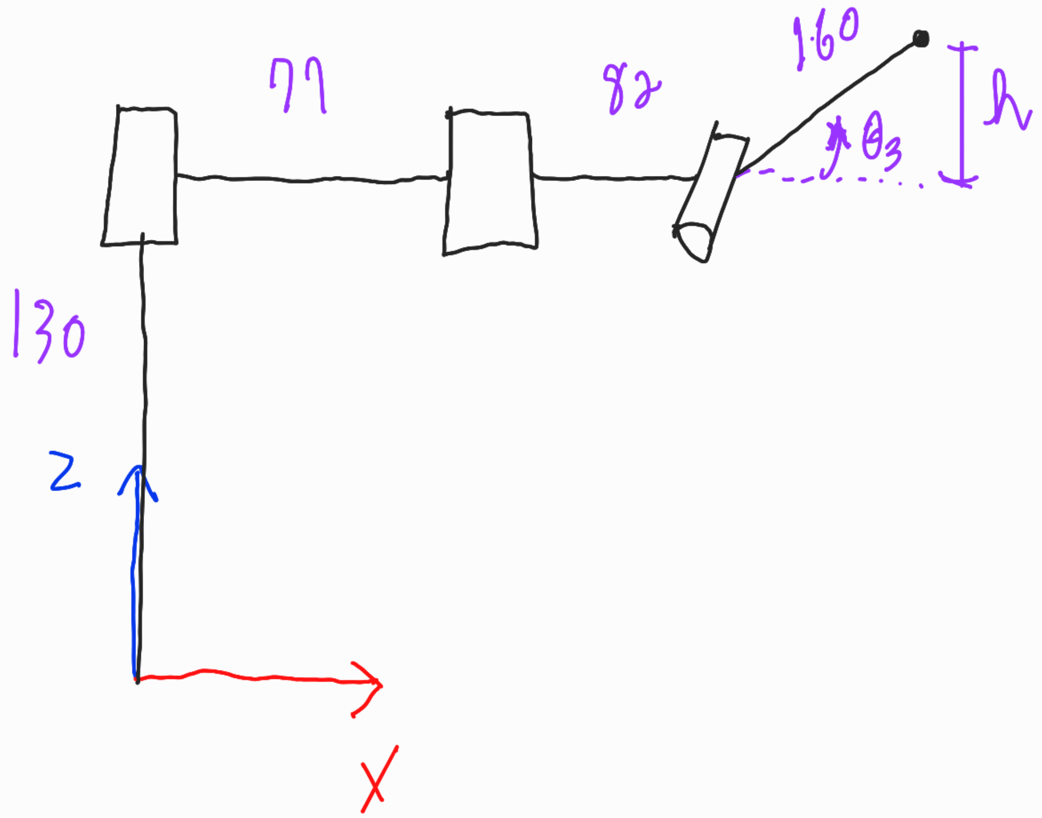
$$H_2^{-1} = \begin{bmatrix} C(1-2) & 0 & S_{12} & 82C_{(1-2)} + 77C_1 \\ S_{12} & 0 & -C_{(1-2)} & 82S_{12} - 77S_1 \\ 0 & 1 & 0 & 130 \\ 0 & 0 & 0 & 1 \end{bmatrix}$$

$$H_3^{-1} = \begin{bmatrix} C(1-2) & 0 & S_{12} & 82C_{(1-2)} + 77C_1 \\ S_{12} & 0 & -C_{(1-2)} & 82S_{12} - 77S_1 \\ 0 & 1 & 0 & 130 \\ 0 & 0 & 0 & 1 \end{bmatrix} \cdot$$

$$\begin{bmatrix} C_3 & -S_3 & 0 & 160C_3 \\ S_3 & C_3 & 0 & 160S_3 \\ 0 & 0 & 1 & 0 \\ 0 & 0 & 0 & 1 \end{bmatrix}$$

$$H_3^{-1} = \begin{bmatrix} C(1-2)C_3 & -C_{(1-2)}S_3 & S_{12} & 160C(1-2)C_3 + 82C_{(1-2)} + 77C_1 \\ S_{12}C_3 & -S_{12}S_3 & -C(1-2) & 160S_{12}C_3 + 82S_{12} - 77S_1 \\ S_3 & C_3 & 0 & 160S_3 + 130 \\ 0 & 0 & 0 & 1 \end{bmatrix}$$

Vista lateral:



$\rightarrow h = 160 \operatorname{sen}(\theta_3)$

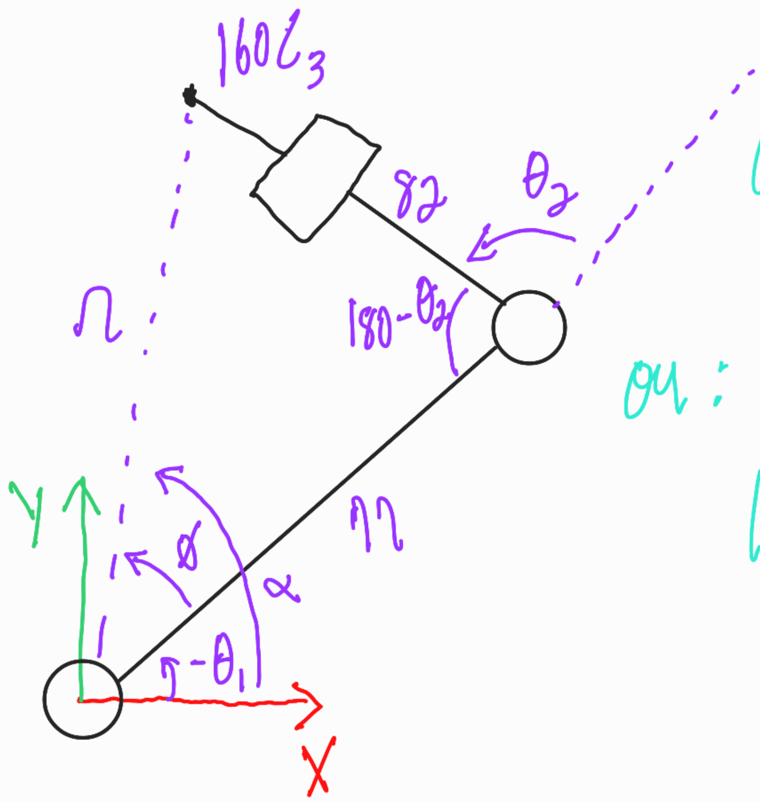
$\rightarrow Z_c = 130 + 160 \operatorname{sen}(\theta_3)$

$\rightarrow S_3 = \dfrac{Z_c - 130}{160}$ *

$\rightarrow \theta_3 = \operatorname{atan2}\left(S_3, \sqrt{1 - S_3^2}\right)$

*

Vista Superior:



Cotovelo direito!

ou: $\theta_2' = 180 - \theta_2$

(rot. sq.)

$$\rightarrow \alpha = \operatorname{atan2}(Y_c, X_c) \; *$$

$$\rightarrow r = \sqrt{X_c^2 + Y_c^2} \; *$$

$$\rightarrow r^2 = 77^2 + (160C_3 + 82)^2 - 2 \cdot 77 \cdot \overbrace{(160C_3 + 82)}^{s \, *} \cdot \cos(180 - \theta_2)$$

$$\cos(180 - \theta_2) = \cos(180)\cos(\theta_2) + \cancel{\operatorname{sen}(180)\operatorname{sen}(\theta_2)}^{0}$$

$$= -\cos(\theta_2)$$

$$\rightarrow C_2 = \frac{r^2 - 77^2 - s^2}{144s} \; *$$

$$\rightarrow \theta_2 = \operatorname{atan2}\left(\sqrt{1 - C_2^2}, C_2\right) \; *$$

$$\rightarrow \frac{s}{\operatorname{sen}(\phi)} = \frac{r}{\operatorname{sen}(180-\theta_2)}$$

$$\operatorname{sen}(180-\theta_2) = \underbrace{\operatorname{sen}(180)}_{\rightarrow 0}\cos(\theta_2) - \operatorname{sen}(\theta_2)\cos(180)$$

$$\hookrightarrow \operatorname{sen}(\theta_2)$$

$$\rightarrow s_\phi = \frac{s\,\operatorname{sen}(\theta_2)}{r} \; *$$

$$\rightarrow \phi = \operatorname{atan2}\left(s_\phi, \sqrt{1-s_\phi^2}\right) \; *$$

$$\rightarrow \alpha = \phi - \theta_1$$

$$\rightarrow \theta_1 = \phi - \alpha \; *$$

Cotovelo direito!

ou: $\theta_1' = \alpha - \phi$

(cot. esq.)