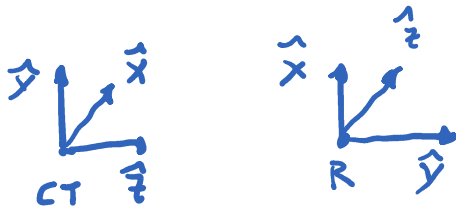


$$\boxed{1} \quad t'_R = {}^R T_{CT} \cdot t_{CT} = \begin{bmatrix} 0 & 1 & 0 & 0 \\ 0 & 0 & 1 & -598 \\ 1 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 \end{bmatrix} \begin{bmatrix} 30 \\ 20 \\ 10 \\ 1 \end{bmatrix} = \begin{bmatrix} 20 \\ 598 \\ 30 \\ 0 \end{bmatrix}$$

$$TRE = \|t_R - t'_R\| = \left\| \begin{pmatrix} 22 \\ -598 \\ 31 \end{pmatrix} - \begin{pmatrix} 20 \\ 598 \\ 30 \end{pmatrix} \right\| = \left\| \begin{pmatrix} 2 \\ 2 \\ 1 \end{pmatrix} \right\| = 3 \text{ mm}$$

$\boxed{2}$



$\boxed{3}$

$$t'_R = R \cdot t_{CT} + t_N \quad \text{Usando la R precedente}$$

$$R = \begin{bmatrix} 0 & 1 & 0 \\ 0 & 0 & 1 \\ 1 & 0 & 0 \end{bmatrix}$$

$$TRE = \|t_R - t'_R\| = 0 \Rightarrow t'_R = t_R$$

$$t_R = R t_{CT} + t_N$$

$$t_N = t_R - R t_{CT} = \begin{pmatrix} 22 \\ -598 \\ 31 \end{pmatrix} - \begin{bmatrix} 0 & 1 & 0 \\ 0 & 0 & 1 \\ 1 & 0 & 0 \end{bmatrix} \begin{pmatrix} 30 \\ 20 \\ 10 \end{pmatrix} = \begin{pmatrix} 22 \\ -598 \\ 31 \end{pmatrix} - \begin{pmatrix} 20 \\ 10 \\ 30 \end{pmatrix} =$$

$$= \begin{pmatrix} 2 \\ -598 \\ 1 \end{pmatrix}$$

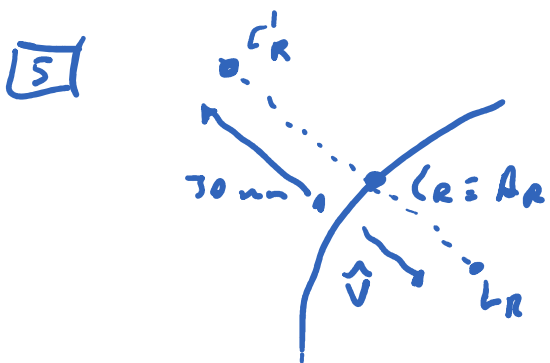
$$R_{N_{CT}} = \begin{bmatrix} 0 & 1 & 0 & 2 \\ 0 & 0 & 1 & -598 \\ 1 & 0 & 0 & 1 \\ 0 & 0 & 0 & 1 \end{bmatrix}$$

$\boxed{5}$  la matrice di calibrazione  ${}^R T_{N_{CT}}$  allinea perfettamente il tar, e spostamento

ma non fornisce garanzie su tutti e 6 i gradi di libertà.

Per poter utilizzare questa matrice sarebbe necessario verificare il TRE su almeno altri 2 punti non collineari con  $C_R$ , preferibilmente nella zona dove sarà eseguito l'intervento.

Sarebbe comunque preferibile ripetere la calibrazione.



$$\hat{U} = \frac{L_R - A_R}{\|L_R - A_R\|}$$

$$\hat{U} = \begin{pmatrix} 20 \\ 10 \\ 30 \end{pmatrix} - \begin{pmatrix} 10 \\ -30 \\ 10 \end{pmatrix} = \begin{pmatrix} 10 \\ 40 \\ 20 \end{pmatrix} = \frac{\begin{pmatrix} 10 \\ 40 \\ 20 \end{pmatrix}}{\| \begin{pmatrix} 10 \\ 40 \\ 20 \end{pmatrix} \|} = \frac{\begin{pmatrix} 10 \\ 40 \\ 20 \end{pmatrix}}{45.8} = \begin{pmatrix} 0.22 \\ 0.87 \\ 0.44 \end{pmatrix}$$

$$C_R' = C_R - \hat{U} \cdot 30 = \begin{pmatrix} 10 \\ 30 \\ 10 \end{pmatrix} - \begin{pmatrix} 0.22 \\ 0.87 \\ 0.44 \end{pmatrix} 30 = \begin{pmatrix} 3.45 \\ -56.1 \\ -3.1 \end{pmatrix}$$