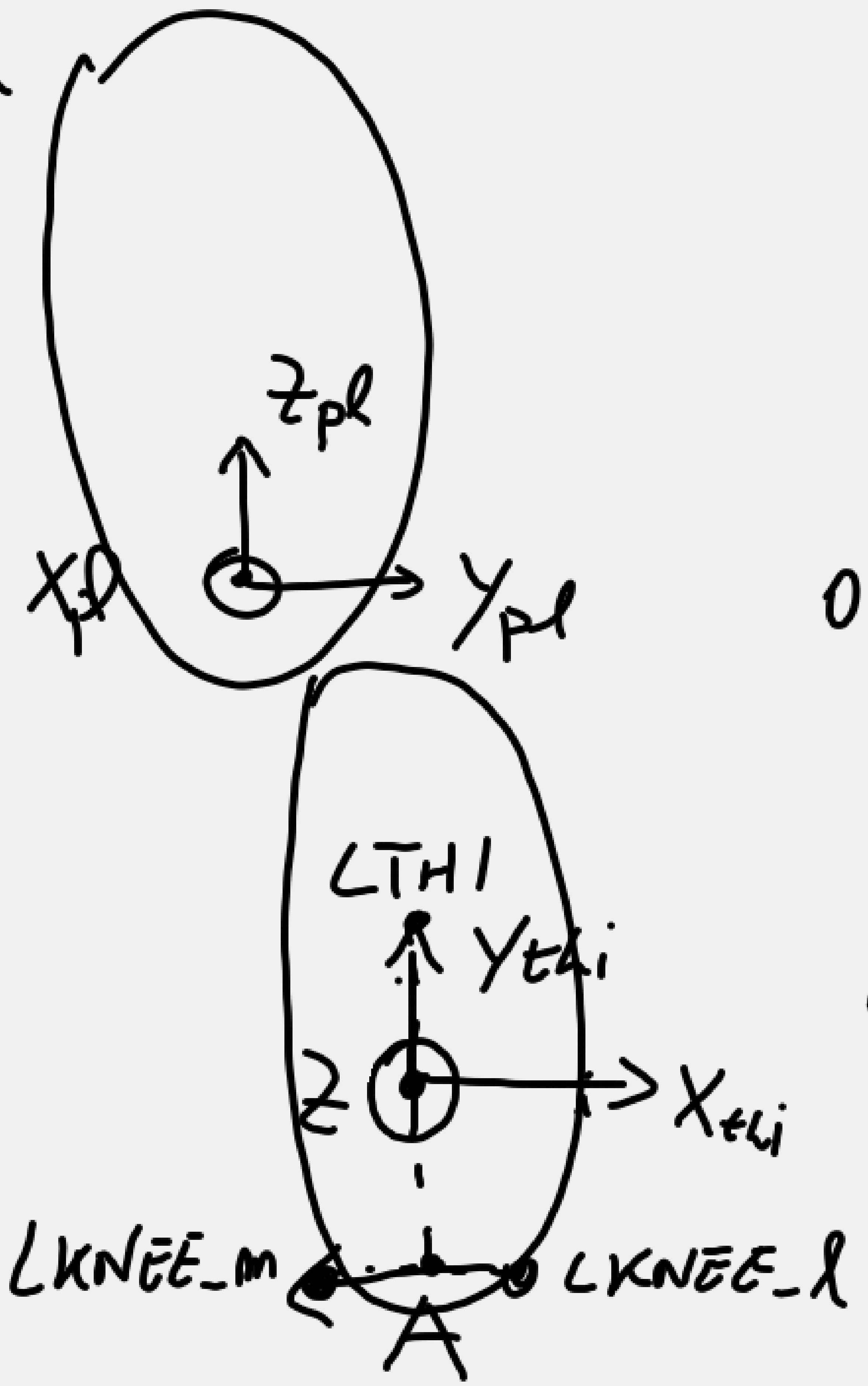
1.a



$$^0A = \frac{LKNEE\_m + LKNEE\_l}{2}$$

$$^0O_{thi} = \frac{^0LTHI + {}^0A}{2}$$

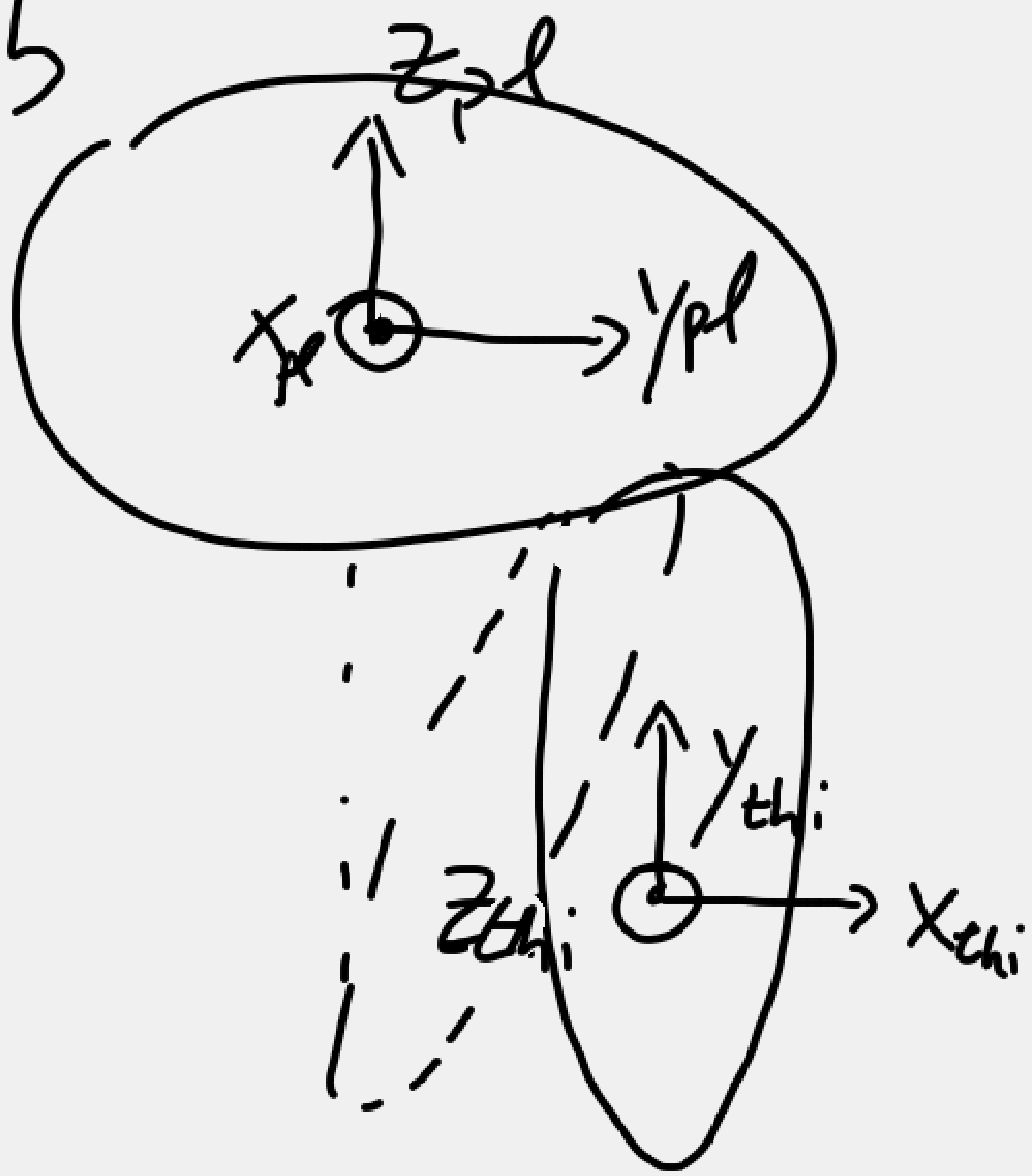
$$^0Y_{thi} = vers\left(LTHI - {}^0O_{thi}\right)$$

$$^0Z_{thi} = vers\left({}^0Y_{thi} \times \left(LKNE\_m - LKNE\_l\right)\right)$$

$$^0X_{thi} = {}^0Y_{thi} \times {}^0Z_{thi}$$

$$
{}^{0}T_{thi} = \begin{bmatrix} | & | & | & | \\ {}^{0}X_{thi} & {}^{0}Y_{thi} & {}^{0}Z_{thi} & {}^{0}O_{thi} \\ | & | & | & | \\ 0 & 0 & 0 & 1 \end{bmatrix}
$$

1b



l_1 : Fl/Ex

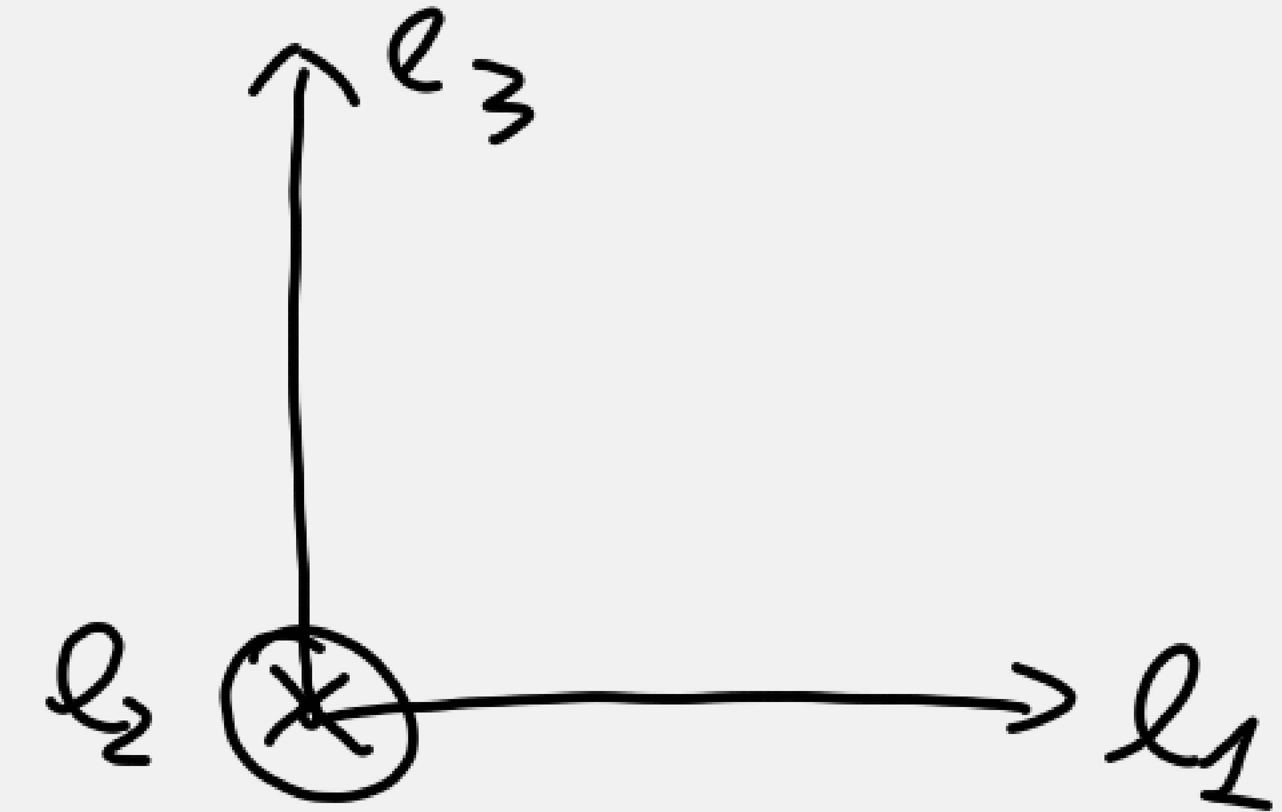
l_2 : Abd/Add

l_3 : In/Ext RoT

$l_1 \parallel y_{pel}$

$l_3 \parallel y_{thi}$

$l_2 \perp l_1, l_3$



l_1 : EST. ⊕

l_2 : ADD ⊕

l_3 : EX ROT ⊕

$Y X' Y''$; $Y Z' Y''$

1c $y\ z'\ y'' \longrightarrow \varphi, \theta, \psi$

$$H(\alpha) \quad {}^{pl}\omega^{pl}_{thi} = H(\alpha)\,\dot{\alpha}$$

$$\omega = \omega_\varphi + \omega_\theta + \omega_\psi$$

$$\omega_\varphi = \begin{bmatrix} 0 \\ \dot{\varphi} \\ 0 \end{bmatrix} \quad ; \quad \omega_\theta = R_y(\varphi)\begin{bmatrix} 0 \\ 0 \\ \dot{\theta} \end{bmatrix}$$

$$\omega_\psi = R_y(\varphi)\,R_z(\theta)\begin{bmatrix} 0 \\ \dot{\psi} \\ 0 \end{bmatrix}$$

$$W_\theta = \begin{bmatrix} c\varphi & 0 & s\varphi \\ 0 & 1 & 0 \\ -s\varphi & 0 & c\varphi \end{bmatrix} \begin{bmatrix} 0 \\ 0 \\ \dot{\theta} \end{bmatrix} = \begin{bmatrix} s\varphi\,\dot{\theta} \\ 0 \\ c\varphi\,\dot{\theta} \end{bmatrix}$$

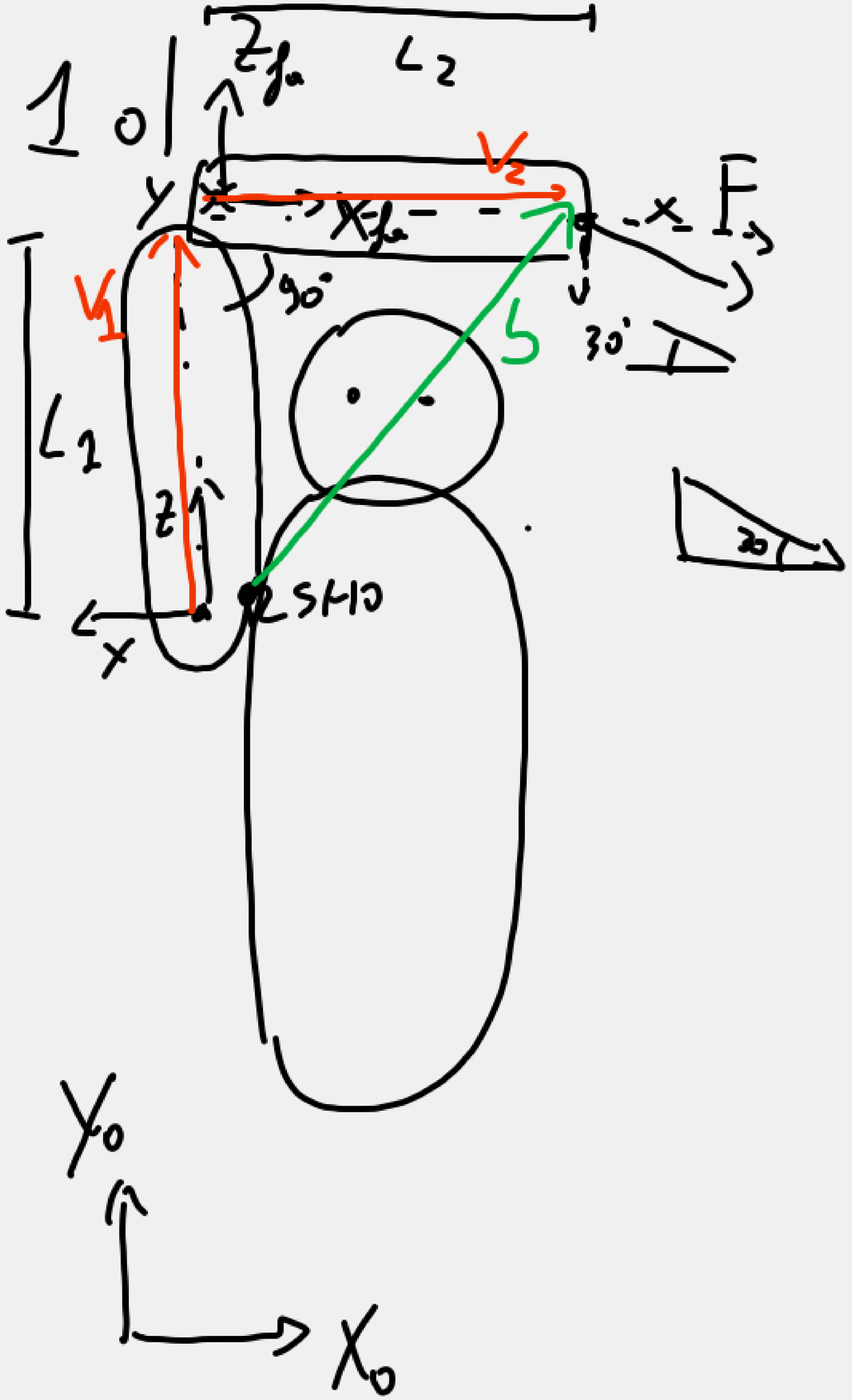
$$w_\psi = \begin{bmatrix} c\varphi & 0 & s\varphi \\ 0 & 1 & 0 \\ -s\varphi & 0 & c\varphi \end{bmatrix} \begin{bmatrix} c\theta & -s\theta & 0 \\ s\theta & c\theta & 0 \\ 0 & 0 & 1 \end{bmatrix} \begin{bmatrix} 0 \\ \dot{\psi} \\ 0 \end{bmatrix}$$

$$W_\psi = \begin{bmatrix} c\varphi & 0 & s\varphi \\ 0 & 1 & 0 \\ -s\varphi & 0 & c\varphi \end{bmatrix} \begin{bmatrix} -s\theta\,\dot{\psi} \\ c\theta\,\dot{\psi} \\ 0 \end{bmatrix} = \begin{bmatrix} -c\varphi\, s\theta\,\dot{\psi} \\ c\theta\,\dot{\psi} \\ s\varphi\, s\theta\,\dot{\psi} \end{bmatrix}$$

$$w = \begin{bmatrix} 0 \\ \dot{\varphi} \\ 0 \end{bmatrix} + \begin{bmatrix} s\varphi\,\dot{\theta} \\ 0 \\ c\varphi\,\dot{\theta} \end{bmatrix} + \begin{bmatrix} -c\varphi\, s\theta\,\dot{\psi} \\ c\theta\,\dot{\psi} \\ s\varphi\, s\theta\,\dot{\psi} \end{bmatrix} = \begin{bmatrix} s\varphi\,\dot{\theta} - c\varphi\, s\theta\,\dot{\psi} \\ \dot{\varphi} + c\theta\,\dot{\psi} \\ c\varphi\,\dot{\theta} + s\varphi\, s\theta\,\dot{\psi} \end{bmatrix}$$

$$w = H \begin{bmatrix} \dot{\varphi} \\ \dot{\theta} \\ \dot{\psi} \end{bmatrix}$$

$$H = \begin{bmatrix} 0 & s\varphi & -c\varphi\, s\theta \\ 1 & 0 & c\theta \\ 0 & c\varphi & s\varphi\, s\theta \end{bmatrix} \begin{bmatrix} \dot{\varphi} \\ \dot{\theta} \\ \dot{\psi} \end{bmatrix} = \begin{bmatrix} s\varphi\,\dot{\theta} - c\varphi\, s\theta\,\dot{\psi} \\ \dot{\varphi} + c\theta\,\dot{\psi} \\ c\varphi\,\dot{\theta} + s\varphi\, s\theta\,\dot{\psi} \end{bmatrix}$$



$${}^{farm}m = ?$$

$$\vec{b} = \vec{V_1} + \vec{V_2}$$

$$\vec{m} = \vec{b} \times \vec{F}$$

$${}^{farm}V_2 = \begin{bmatrix} 250 \\ 0 \\ 0 \end{bmatrix} mm$$

$${}^{farm}m = {}^{farm}b \times {}^{farm}F$$

$${}^{farm}V_1 = \begin{bmatrix} 0 \\ 0 \\ 270 \end{bmatrix} mm$$

$${}^{farm}F = \begin{bmatrix} \frac{\sqrt{3}}{2} \\ 0 \\ -\frac{1}{2} \end{bmatrix} \cdot 50N$$

$${}^{farm}b = \begin{bmatrix} 0 \\ 0 \\ 270 \end{bmatrix} + \begin{bmatrix} 250 \\ 0 \\ 0 \end{bmatrix} = \begin{bmatrix} 250 \\ 0 \\ 270 \end{bmatrix} mm$$

$$\underline{\underline{{}^{farm}V_1}} = \left({}^{farm}R_{arm}\right) \underline{{}^{arm}V_1}$$

$$R_z(180) = \begin{pmatrix} -1 & 0 & 0 \\ 0 & -1 & 0 \\ 0 & 0 & 1 \end{pmatrix}$$

$$\begin{array}{c} \\ \| \\ R_z(180) \begin{bmatrix} 0 \\ 0 \\ 1 \end{bmatrix} \end{array}$$

$${}^{far}R_{arm} = \begin{pmatrix} | & | & | \\ {}^{far}X_{arm} & {}^{far}Y_{arm} & {}^{farm}Z_{arm} \\ | & | & | \end{pmatrix}$$

$$= \begin{pmatrix} -1 & 0 & 0 \\ 0 & -1 & 0 \\ 0 & 0 & 1 \end{pmatrix}$$

$$b = \begin{bmatrix} 0,25 \\ 0 \\ 0,27 \end{bmatrix} m$$

$$\begin{vmatrix} i & j & k & i & j \\ 0,25 & 0 & 0,27 & 0,25 & 0 \\ \frac{\sqrt{3}}{2}50 & 0 & -\frac{50}{2} & \frac{\sqrt{3}}{2}50 & 0 \end{vmatrix} =$$

$$= j\left(\overset{m}{0,27} \cdot \overset{N}{\frac{\sqrt{3}}{2}50}\right) - j\left(\overset{m}{0,25} \cdot \overset{N}{-\frac{50}{2}}\right) = j\ 17,94\ Nm$$

$$^{\text{form}}m = \begin{bmatrix} 0 \\ 17{,}94 \\ 0 \end{bmatrix} Nm$$