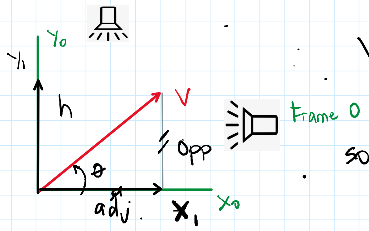
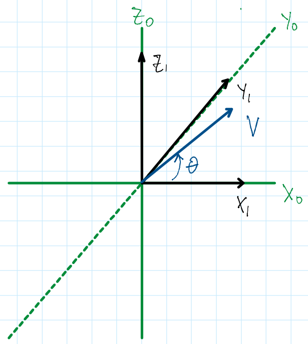
Projection



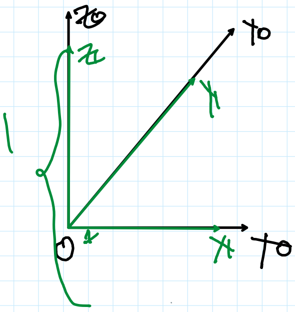
$V = (x_1, y_1)$

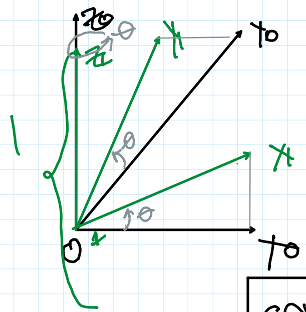
$\tan\theta = \frac{y_1}{x_1}$

SOH CAH TOA



$V = (x_1, y_1, z_1)$





RM: How the rotation of Fn is projected on Fn-1.

$$\begin{array}{c|ccc} & X_n & Y_n & Z_n \\ \hline X_{n-1} & \square & \square & \square \\ Y_{n-1} & \square & \square & \square \\ Z_{n-1} & \square & \square & \square \end{array}$$

$$\begin{array}{c|ccc} & X_1 & Y_1 & Z_1 \\ \hline X_0 & C\theta & -S\theta & 0 \\ Y_0 & S\theta & C\theta & 0 \\ Z_0 & 0 & 0 & 1 \end{array}$$

"Z Rotation Matrix"

$\boxed{\text{SOH CAH TOA}}$

$$\begin{array}{c|ccc} & X_1 & Y_1 & Z_1 \\ \hline X_0 & 1 & 0 & 0 \\ Y_0 & 0 & C\theta & -S\theta \\ Z_0 & 0 & S\theta & C\theta \end{array}$$

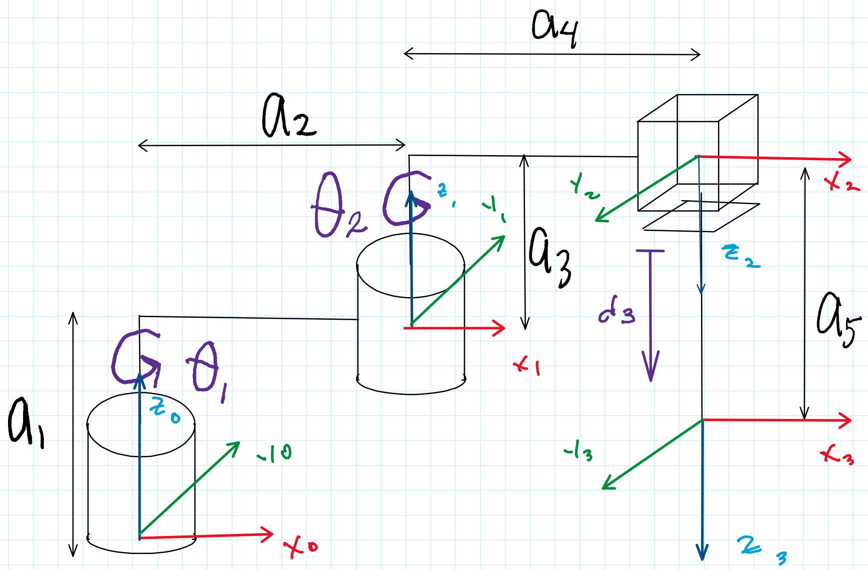
"X Rotation Matrix"

$$\begin{array}{c|ccc} & X_1 & Y_1 & Z_1 \\ \hline X_0 & C\theta & 0 & S\theta \\ Y_0 & 0 & 1 & 0 \\ Z_0 & -S\theta & 0 & C\theta \end{array}$$

"Y Rotation Matrix"

$$\begin{array}{c|ccc} & X_1 & Y_1 & Z_1 \\ \hline X_0 & C\theta & -S\theta & 0 \\ Y_0 & S\theta & C\theta & 0 \\ Z_0 & 0 & 0 & 1 \end{array}$$

"Z Rotation Matrix"



$$
{}^0_1R = \begin{array}{c|ccc} & X_1 & Y_1 & Z_1 \\ \hline x_0 & 1 & 0 & 0 \\ y_0 & 0 & 1 & 0 \\ z_0 & 0 & 0 & 1 \end{array} * \begin{bmatrix} c\theta_1 & -s\theta_1 & 0 \\ s\theta_1 & c\theta_1 & 0 \\ 0 & 0 & 1 \end{bmatrix}
$$

"stationary matrix" "Z Rotation Matrix" "moving matrix"

$$
{}^0_1R = \begin{bmatrix} c\theta_1 & -s\theta_1 & 0 \\ s\theta_1 & c\theta_1 & 0 \\ 0 & 0 & 1 \end{bmatrix}
$$

$$
{}^1_2R = \begin{array}{c|ccc} & X_2 & Y_2 & Z_2 \\ \hline x_1 & 1 & 0 & 0 \\ y_1 & 0 & -1 & 0 \\ z_1 & 0 & 0 & -1 \end{array} * \begin{bmatrix} c\theta_2 & -s\theta_2 & 0 \\ s\theta_2 & c\theta_2 & 0 \\ 0 & 0 & 1 \end{bmatrix} \qquad {}^1_2R = \begin{bmatrix} c\theta_2 & -s\theta_2 & 0 \\ -s\theta_2 & -c\theta_2 & 0 \\ 0 & 0 & -1 \end{bmatrix}
$$

"stationary matrix" "Z Rotation Matrix" "moving matrix"

$$
{}^2_3R = \begin{array}{c|ccc} & X_3 & Y_3 & Z_3 \\ \hline x_2 & 1 & 0 & 0 \\ y_2 & 0 & 1 & 0 \\ z_2 & 0 & 0 & 1 \end{array} * \begin{bmatrix} 1 & 0 & 0 \\ 0 & 1 & 0 \\ 0 & 0 & 1 \end{bmatrix}
$$

"stationary "moving

$$z_2 \begin{bmatrix} 0 & 0 & 1 \end{bmatrix} \cdot \begin{bmatrix} 0 & 0 & 1 \end{bmatrix}$$

"stationary matrix"

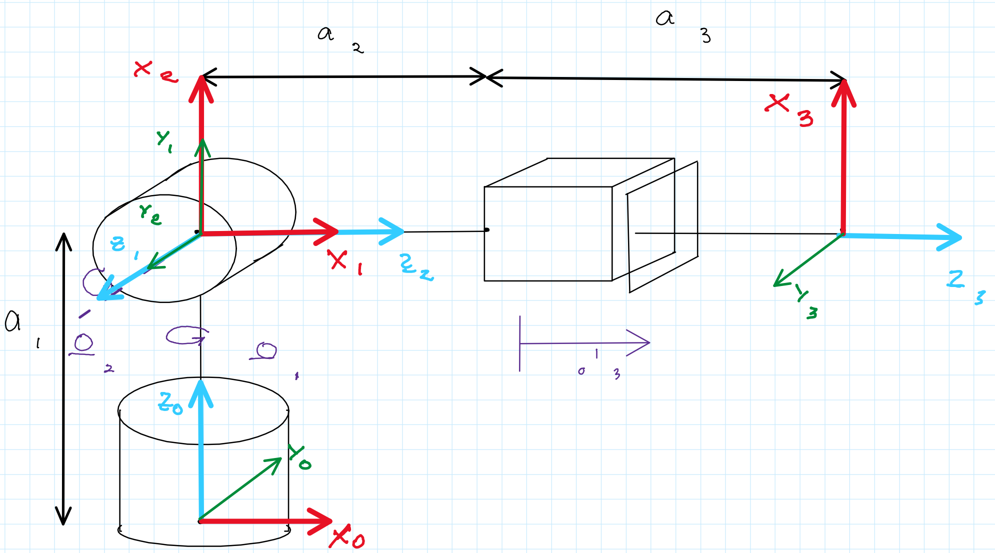
"moving matrix"

$$ {}^{2}_{3}R = \begin{bmatrix} 1 & 0 & 0 \\ 0 & 1 & 0 \\ 0 & 0 & 1 \end{bmatrix} $$

$$ {}^{0}_{3}R = {}^{0}_{1}R * {}^{1}_{2}R * {}^{2}_{3}R $$

$$ {}^{0}_{3}R = \begin{bmatrix} c\theta_1 & -s\theta_1 & 0 \\ s\theta_1 & c\theta_1 & 0 \\ 0 & 0 & 1 \end{bmatrix} * \begin{bmatrix} c\theta_2 & -s\theta_2 & 0 \\ -s\theta_2 & -c\theta_2 & 0 \\ 0 & 0 & -1 \end{bmatrix} * \begin{bmatrix} 1 & 0 & 0 \\ 0 & 1 & 0 \\ 0 & 0 & 1 \end{bmatrix} $$

3. Spherical



"Z Rotation Matrix"

$$ {}^{0}_{1}R = \begin{array}{c|ccc} & x_1 & y_1 & z_1 \\ \hline x_0 & & & \\ y_0 & & \begin{bmatrix} 1 & 0 & 0 \\ 0 & 0 & -1 \\ 0 & 1 & 0 \end{bmatrix} & \\ z_0 & & & \end{array} * \begin{bmatrix} c\theta_1 & -s\theta_1 & 0 \\ s\theta_1 & c\theta_1 & 0 \\ 0 & 0 & 1 \end{bmatrix} $$

"stationary matrix"

"moving matrix"

"stationary matrix" "moving matrix"

$$ {}^0_1R = \begin{bmatrix} c\theta_1 & -s\theta_1 & 0 \\ 0 & 0 & -1 \\ s\theta_1 & c\theta_1 & 0 \end{bmatrix} $$

~~"Z Rotation Matrix"~~

$$ {}^1_2R = \begin{bmatrix} c\theta_2 & -s\theta_2 & 0 \\ s\theta_2 & c\theta_2 & 0 \\ 0 & 0 & 1 \end{bmatrix} * \begin{array}{c c} & \begin{array}{ccc} X_2 & Y_2 & Z_2 \end{array} \\ \begin{array}{c} X_1 \\ Y_1 \\ Z_1 \end{array} & \begin{bmatrix} 0 & 0 & 1 \\ 1 & 0 & 0 \\ 0 & 1 & 0 \end{bmatrix} \end{array} \qquad {}^1_2R = \begin{bmatrix} -s\theta_2 & 0 & c\theta_2 \\ c\theta_2 & 0 & s\theta_2 \\ 0 & 1 & 0 \end{bmatrix} $$

"moving matrix" "stationary matrix"

OR

"Y Rotation Matrix"

$$ {}^1_2R = \begin{array}{c c} & \begin{array}{ccc} X_2 & Y_2 & Z_2 \end{array} \\ \begin{array}{c} X_1 \\ Y_1 \\ Z_1 \end{array} & \begin{bmatrix} 0 & 0 & 1 \\ 1 & 0 & 0 \\ 0 & 1 & 0 \end{bmatrix} \end{array} * \begin{array}{c c} & \begin{array}{ccc} X_1 & Y_1 & Z_1 \end{array} \\ \begin{array}{c} X_0 \\ Y_0 \\ Z_0 \end{array} & \begin{bmatrix} c\theta_2 & 0 & s\theta_2 \\ 0 & 1 & 0 \\ -s\theta_2 & 0 & c\theta_2 \end{bmatrix} \end{array} \qquad {}^1_2R = \begin{bmatrix} -s\theta_2 & 0 & c\theta_2 \\ c\theta_2 & 0 & s\theta_2 \\ 0 & 1 & 0 \end{bmatrix} $$

"stationary matrix" "moving matrix"

$$ {}^2_3R = \begin{array}{c c} & \begin{array}{ccc} X_3 & Y_3 & Z_3 \end{array} \\ \begin{array}{c} X_2 \\ Y_2 \\ Z_2 \end{array} & \begin{bmatrix} 1 & 0 & 0 \\ 0 & 1 & 0 \\ 0 & 0 & 1 \end{bmatrix} \end{array} * \begin{bmatrix} 1 & 0 & 0 \\ 0 & 1 & 0 \\ 0 & 0 & 1 \end{bmatrix} $$

"stationary matrix" "moving matrix"

$$
{}^{2}_{3}R = \begin{bmatrix} 1 & 0 & 0 \\ 0 & 1 & 0 \\ 0 & 0 & 1 \end{bmatrix}
$$

$$
{}^{0}_{3}R = {}^{0}_{1}R * {}^{1}_{2}R * {}^{2}_{3}R
$$

$$
{}^{0}_{3}R = \begin{bmatrix} c\theta_1 & -s\theta_1 & 0 \\ 0 & 0 & -1 \\ s\theta_1 & c\theta_1 & 0 \end{bmatrix} * \begin{bmatrix} -s\theta_2 & 0 & c\theta_2 \\ c\theta_2 & 0 & s\theta_2 \\ 0 & 1 & 0 \end{bmatrix} * \begin{bmatrix} 1 & 0 & 0 \\ 0 & 1 & 0 \\ 0 & 0 & 1 \end{bmatrix}
$$