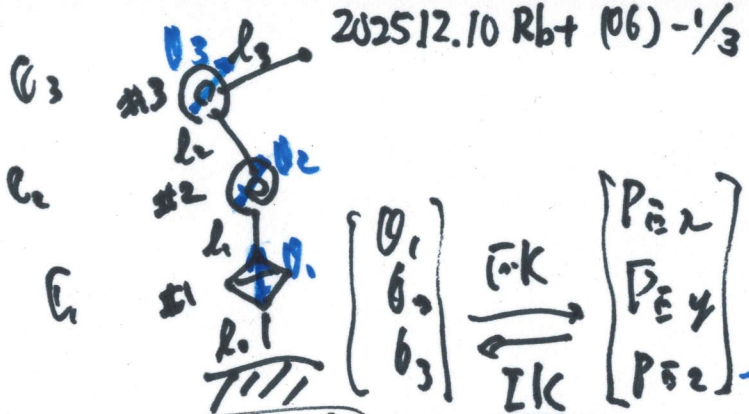




$$\begin{bmatrix} \theta_1 \\ \theta_2 \\ \theta_3 \end{bmatrix} \xrightarrow{\begin{bmatrix} -K \\ IK \end{bmatrix}} \begin{bmatrix} P_{\theta 1} \\ P_{\theta 2} \\ P_{\theta 3} \end{bmatrix}$$

Scalar Geometrical



V.M



input $\Delta \vec{P}_E$

$+ \Delta P_1 + \Delta P_2 + \Delta P_3$
 $- \Delta P_1 - \Delta P_2 - \Delta P_3$

- Step 1 $G \left(\frac{F}{I} \right)$
- Step 2 $\left(\frac{F VM}{I G} \right)$
- Step 3 $\left(\frac{F VM}{I J} \right)$



IK

J

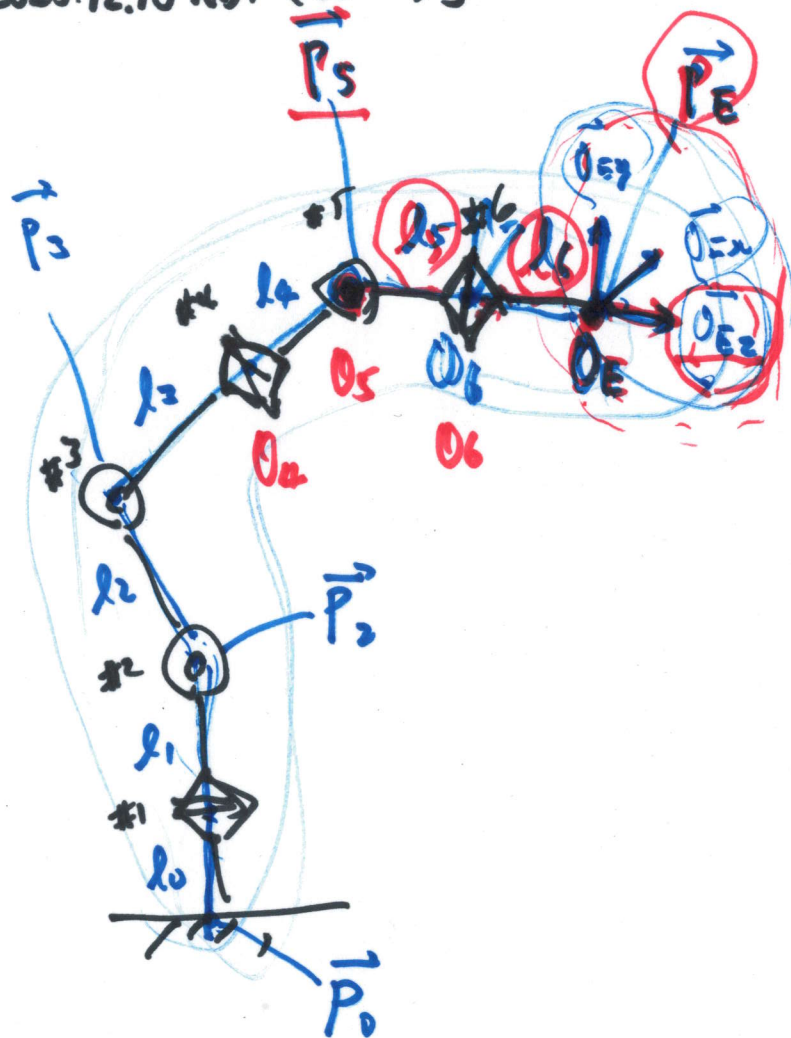
$$\begin{bmatrix} \frac{d}{dt} P_{\theta 1} \\ \frac{d}{dt} P_{\theta 2} \\ \frac{d}{dt} P_{\theta 3} \end{bmatrix} = J \begin{bmatrix} \dot{\theta}_1 \\ \dot{\theta}_2 \\ \dot{\theta}_3 \end{bmatrix}$$

$$\begin{bmatrix} \Delta \theta_1 \\ \Delta \theta_2 \\ \Delta \theta_3 \end{bmatrix} = J \begin{bmatrix} P_{\theta 1} \\ P_{\theta 2} \\ P_{\theta 3} \end{bmatrix}$$

$$J = \begin{bmatrix} \vec{r}_1 \times (\vec{P}_E - \vec{P}_1) & \vec{r}_2 \times (\vec{P}_E - \vec{P}_2) & \vec{r}_3 \times (\vec{P}_E - \vec{P}_3) \\ \vdots & \vdots & \vdots \end{bmatrix}$$

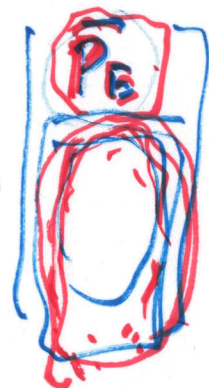
$$J = \begin{bmatrix} \vec{r}_1 \times (\vec{P}_E - \vec{P}_1) & \vec{r}_2 \times (\vec{P}_E - \vec{P}_2) & \vec{r}_3 \end{bmatrix}$$

2025.12.10 Rb+ (6) - 2/3



$\begin{bmatrix} O_1 \\ O_2 \\ O_3 \\ O_6 \end{bmatrix}$

FK



IK

$$\begin{bmatrix} O_E (\vec{O}_{Ex} \vec{O}_{Ey} \vec{O}_{Ez}) \\ O_6 (\vec{O}_{6x} \vec{O}_{6y} \vec{O}_{6z}) \end{bmatrix}$$

(1) $\vec{P}_5 = \vec{P}_E - \vec{z}_E(l_1 + l_5)$

IK

[2]

$$\begin{bmatrix} \theta_1 & \theta_2 & \theta_3 \end{bmatrix}$$

(3)

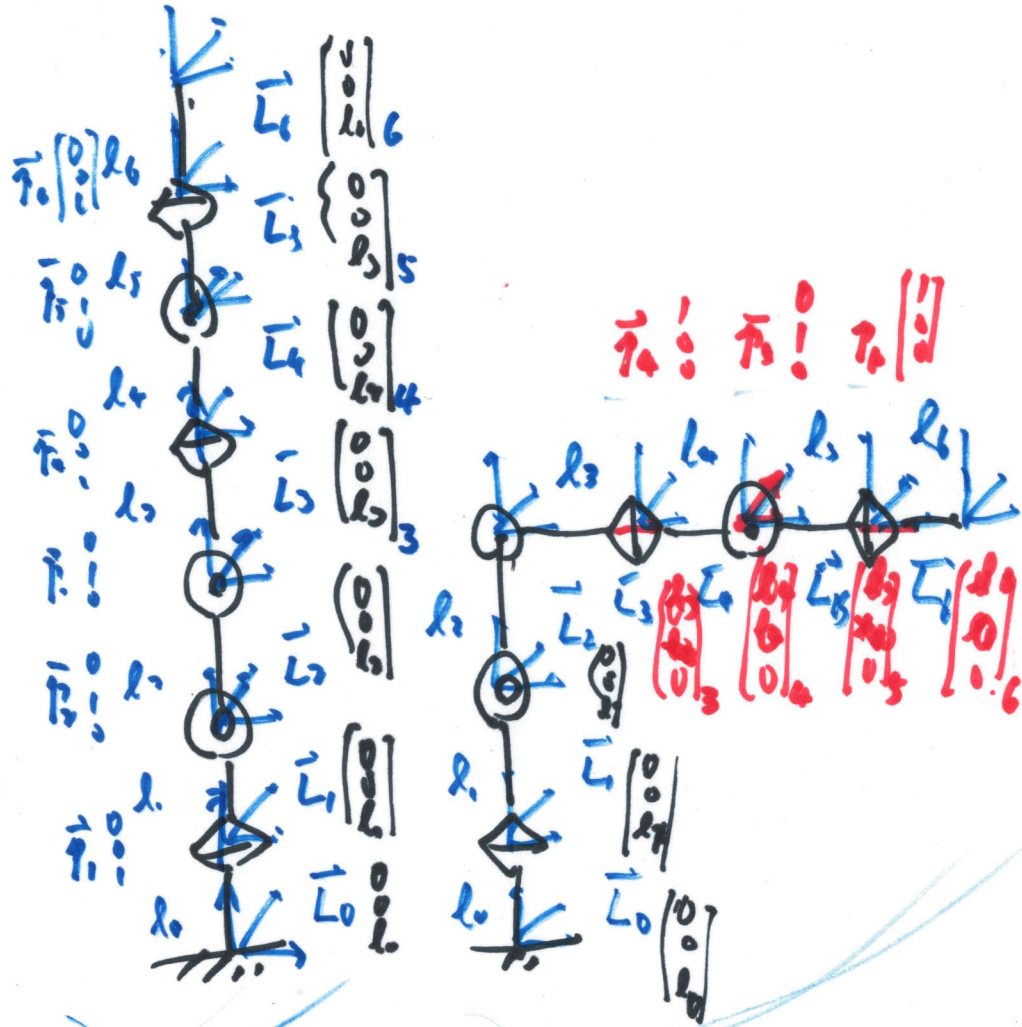
$$\begin{bmatrix} \vec{P}_5, O_5 (\vec{O}_{5x} \vec{O}_{5y} \vec{O}_{5z}) \\ \vec{P}_3, O_3 (\vec{O}_{3x} \vec{O}_{3y} \vec{O}_{3z}) \\ O_6 (\vec{O}_{6x} \vec{O}_{6y} \vec{O}_{6z}) \end{bmatrix}$$

$$\underline{O_6}_{3 \times 3} = \underline{O_3}_{3 \times 3} \cdot \begin{bmatrix} \cdot & \cdot & \cdot \\ \cdot & \cdot & \cdot \\ \cdot & \cdot & \cdot \end{bmatrix}_{3 \times 3}$$

$\theta_4 \theta_5 \theta_6$
Euler angle
 $\phi \theta \psi$

[4]

2025.12.10 Rbt (P) - 3/3



F, K (unit dimension)



$\theta_1, \theta_2, s_1, s_2$