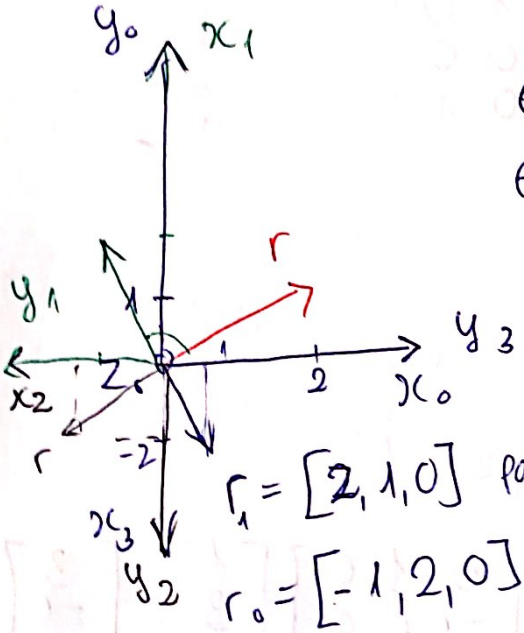
P2 Service Robot

Składanie obrotów

- mamy 10 przykładów (5-6) obrotów (4-5) złożenie obrotów



$\theta_1 = 90^\circ$

$\theta_2 = 90^\circ$ $\quad r_0 = R_{1,0} \cdot r_1$

$$= \begin{bmatrix} 0 & -1 & 0 \\ +1 & 0 & 0 \\ 0 & 0 & 1 \end{bmatrix} \begin{bmatrix} 2 \\ 1 \\ 0 \end{bmatrix} = \begin{bmatrix} -1 \\ 2 \\ 0 \end{bmatrix}$$

$r_1 = [2, 1, 0]$ początkowa

$r_0 = [-1, 2, 0]$

$\theta_2 = 90^\circ$: $\quad r_0 = R_{2,0} \cdot r_2 \qquad r_2 = [2, 1, 0]$

$$R_{2,0} = R_{1,0} \cdot R_{21} = \begin{bmatrix} 0 & -1 & 0 \\ 1 & 0 & 0 \\ 0 & 0 & 1 \end{bmatrix} \begin{bmatrix} 0 & -1 & 0 \\ 1 & 0 & 0 \\ 0 & 0 & 1 \end{bmatrix} = \begin{bmatrix} -1 & 0 & 0 \\ 0 & -1 & 0 \\ 0 & 0 & 1 \end{bmatrix}$$

$$r_0 = \begin{bmatrix} -1 & 0 & 0 \\ 0 & -1 & 0 \\ 0 & 0 & 1 \end{bmatrix} \begin{bmatrix} 2 \\ 1 \\ 0 \end{bmatrix} = \begin{bmatrix} -2 \\ -1 \\ 0 \end{bmatrix}$$

④ $\theta_1 = 90 \quad \theta_2 = 90 \quad \theta_3 = 90$

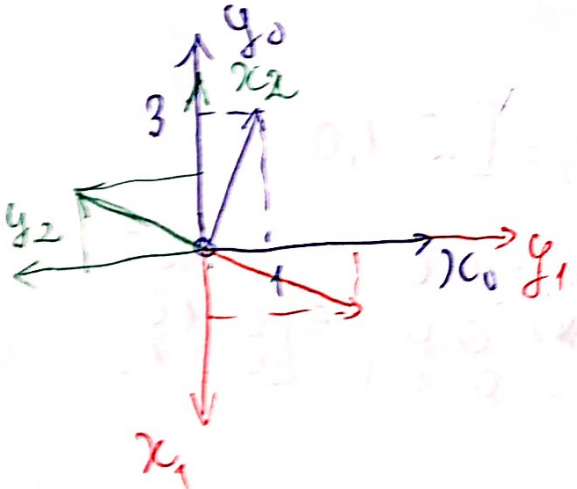
$$r_3 = \begin{bmatrix} 2 \\ 1 \\ 0 \end{bmatrix} \qquad r_0 = R_{3,0}\, r_3$$

$$R_{30} = R_{10} \cdot R_{21} \cdot R_{32} = \begin{bmatrix} 0 & -1 & 0 \\ 1 & 0 & 0 \\ 0 & 0 & 1 \end{bmatrix} \begin{bmatrix} 0 & -1 & 0 \\ 1 & 0 & 0 \\ 0 & 0 & 1 \end{bmatrix} \begin{bmatrix} 0 & -1 & 0 \\ 1 & 0 & 0 \\ 0 & 0 & 1 \end{bmatrix}$$

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

$$\Rightarrow r_0 = \begin{bmatrix} 0 & 1 & 0 \\ -1 & 0 & 0 \\ 0 & 0 & 1 \end{bmatrix} \begin{bmatrix} 2 \\ 1 \\ 0 \end{bmatrix} = \begin{bmatrix} 1 \\ -2 \\ 0 \end{bmatrix}$$

⑤ $\theta_1 = 270°$



$$r_1 = [1, 3, 0]$$

$$r_0 = R_{10} \cdot r_1 = \begin{bmatrix} 0 & 1 & 0 \\ -1 & 0 & 0 \\ 0 & 0 & 1 \end{bmatrix} \begin{bmatrix} 1 \\ 3 \\ 0 \end{bmatrix} = \begin{bmatrix} 3 \\ -1 \\ 0 \end{bmatrix}$$

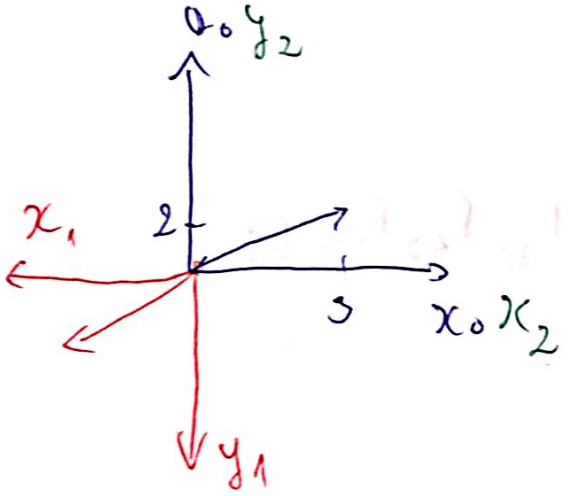
⑥ $\theta_1 = 270 \quad \theta_2 = 180$

$$r_2 = \begin{bmatrix} 1 \\ 3 \\ 0 \end{bmatrix} \qquad r_0 = R_{20} \cdot r_2 = R_{10} \cdot R_{21} \cdot r_2$$

$$r_0 = \begin{bmatrix} 0 & 1 & 0 \\ -1 & 0 & 0 \\ 0 & 0 & 1 \end{bmatrix} \begin{bmatrix} -1 & 0 & 0 \\ 0 & -1 & 0 \\ 0 & 0 & 1 \end{bmatrix} \begin{bmatrix} 1 \\ 3 \\ 0 \end{bmatrix} = \begin{bmatrix} 0 & -1 & 0 \\ 1 & 0 & 0 \\ 0 & 0 & 1 \end{bmatrix} \begin{bmatrix} 1 \\ 3 \\ 0 \end{bmatrix}$$

$$= \begin{bmatrix} -3 \\ 1 \\ 0 \end{bmatrix}$$

⊛ $\theta_1 = 180 \quad \theta_2 = 180 \quad r = \begin{bmatrix} 3 \\ 2 \\ 0 \end{bmatrix}$



$r_0 = R_{20} \cdot r_2$

$= R_{10} \cdot R_{21} \cdot r_2$

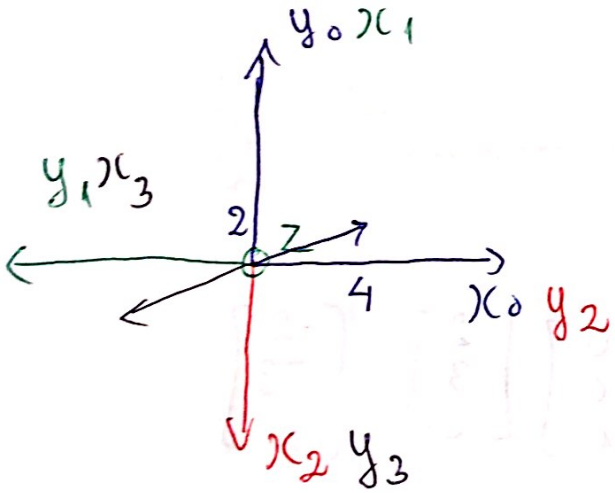
$= \begin{bmatrix} -1 & 0 & 0 \\ 0 & -1 & 0 \\ 0 & 0 & 1 \end{bmatrix} \begin{bmatrix} -1 & 0 & 0 \\ 0 & -1 & 0 \\ 0 & 0 & 1 \end{bmatrix} \begin{bmatrix} 3 \\ 2 \\ 0 \end{bmatrix}$

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

$r_1 = R_{10} \cdot r_2 = \begin{bmatrix} -1 & 0 & 0 \\ 0 & -1 & 0 \\ 0 & 0 & 1 \end{bmatrix} \begin{bmatrix} 3 \\ 2 \\ 0 \end{bmatrix}$

$= \begin{bmatrix} -3 \\ -2 \\ 0 \end{bmatrix}$

⊛ $\theta_1 = 90 \quad \theta_2 = 180 \quad \theta_3 = 270 \quad r = \begin{bmatrix} 4 \\ 2 \\ 0 \end{bmatrix}$



$r_0 = R_{30} \cdot r_3 = R_{10} \cdot R_{21} \cdot R_{32} \cdot r_3$

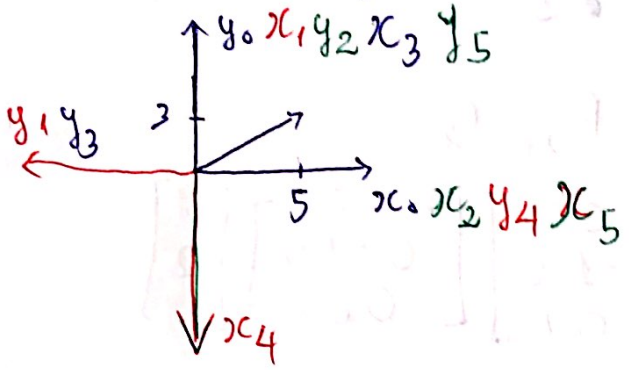
$= \begin{bmatrix} 0 & -1 & 0 \\ 1 & 0 & 0 \\ 0 & 0 & 1 \end{bmatrix} \begin{bmatrix} -1 & 0 & 0 \\ 0 & -1 & 0 \\ 0 & 0 & 1 \end{bmatrix} \begin{bmatrix} 0 & 1 & 0 \\ -1 & 0 & 0 \\ 0 & 0 & 1 \end{bmatrix} \begin{bmatrix} 4 \\ 2 \\ 0 \end{bmatrix}$

$= \begin{bmatrix} 0 & 1 & 0 \\ -1 & 0 & 0 \\ 0 & 0 & 1 \end{bmatrix} \begin{bmatrix} 0 & 1 & 0 \\ -1 & 0 & 0 \\ 0 & 0 & 1 \end{bmatrix} \begin{bmatrix} 4 \\ 2 \\ 0 \end{bmatrix}$

$= \begin{bmatrix} -1 & 0 & 0 \\ 0 & -1 & 0 \\ 0 & 0 & 1 \end{bmatrix} \begin{bmatrix} 4 \\ 2 \\ 0 \end{bmatrix} = \begin{bmatrix} -4 \\ -2 \\ 0 \end{bmatrix}$

⊛ $\theta_1 = 90 \quad \theta_2 = 270 \quad \theta_3 = 90 \quad \theta_4 = 180 \quad \theta_5 = 90$

$r = \begin{bmatrix} 5 \\ 3 \\ 0 \end{bmatrix}$



$r_0 = R_{50} \cdot r_5$

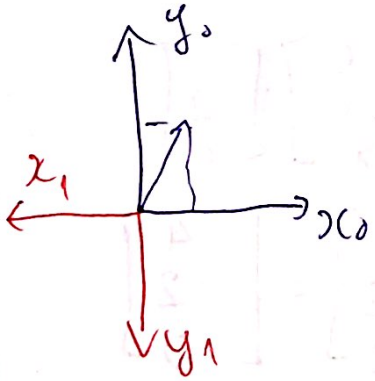
$= R_{10} \cdot R_{21} \cdot R_{32} \cdot R_{43} R_{54}\, r_5$

$$r_0 = \begin{bmatrix} 0 & -1 & 0 \\ 1 & 0 & 0 \\ 0 & 0 & 1 \end{bmatrix} \begin{bmatrix} 0 & 1 & 0 \\ -1 & 0 & 0 \\ 0 & 0 & 1 \end{bmatrix} \begin{bmatrix} 0 & -1 & 0 \\ 1 & 0 & 0 \\ 0 & 0 & 1 \end{bmatrix} \begin{bmatrix} -1 & 0 & 0 \\ 0 & -1 & 0 \\ 0 & 0 & 1 \end{bmatrix} \begin{bmatrix} 0 & -1 & 0 \\ 1 & 0 & 0 \\ 0 & 0 & 1 \end{bmatrix} \begin{bmatrix} 5 \\ 3 \\ 0 \end{bmatrix}$$

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

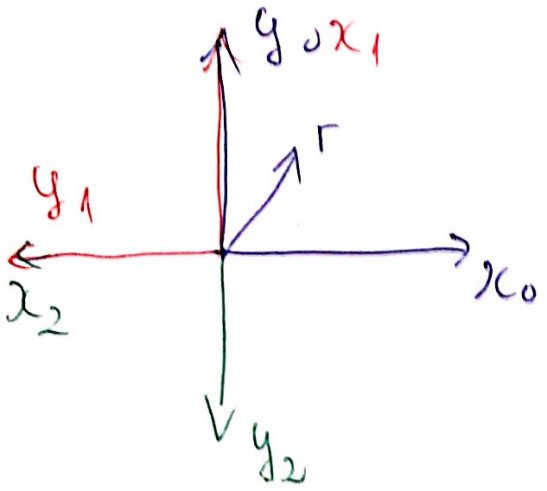
$$r_0 = \begin{bmatrix} 1 & 0 & 0 \\ 0 & 1 & 0 \\ 0 & 0 & 1 \end{bmatrix} \begin{bmatrix} 5 \\ 3 \\ 0 \end{bmatrix} = \begin{bmatrix} 5 \\ 3 \\ 0 \end{bmatrix}$$

⊛ $\theta_1 = 180 \qquad r = \begin{bmatrix} 2 \\ 3 \\ 0 \end{bmatrix}$



$$r_0 = R_{10} \cdot r = \begin{bmatrix} -1 & 0 & 0 \\ 0 & -1 & 0 \\ 0 & 0 & 1 \end{bmatrix} \begin{bmatrix} 2 \\ 3 \\ 0 \end{bmatrix} = \begin{bmatrix} -2 \\ -3 \\ 0 \end{bmatrix}$$

(ب) $\theta_1 = 90 \quad \theta_2 = 90 \quad r = \begin{bmatrix} 2 \\ 3 \\ 0 \end{bmatrix}$

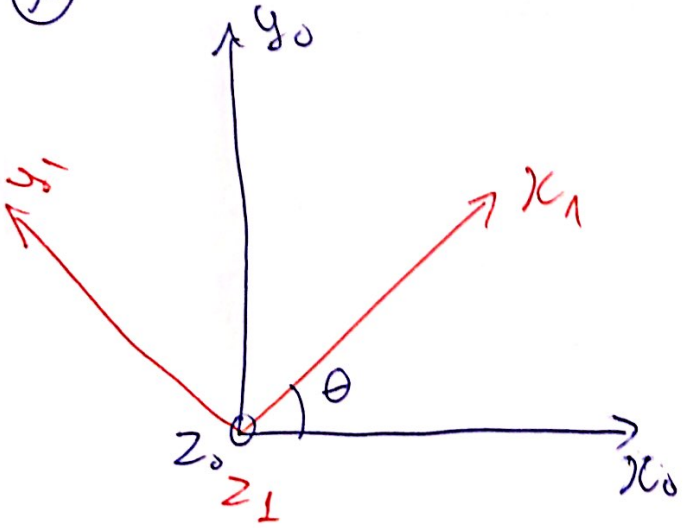


$$r_0 = R_{20} \cdot r_2 = R_{10} \cdot R_{21} \cdot r_2$$

$$= \begin{bmatrix} 0 & -1 & 0 \\ 1 & 0 & 0 \\ 0 & 0 & 1 \end{bmatrix} \begin{bmatrix} 0 & -1 & 0 \\ 1 & 0 & 0 \\ 0 & 0 & 1 \end{bmatrix} \begin{bmatrix} 2 \\ 3 \\ 0 \end{bmatrix}$$

$$= \begin{bmatrix} -1 & 0 & 0 \\ 0 & -1 & 0 \\ 0 & 0 & 1 \end{bmatrix} \begin{bmatrix} 2 \\ 3 \\ 0 \end{bmatrix} = \begin{bmatrix} -2 \\ -3 \\ 0 \end{bmatrix}$$

(ا)



$$R_{10} = \begin{bmatrix} \cos\theta & \cos(90+\theta) & \cos 90 \\ \cos(90-\theta) & \cos\theta & \cos 90 \\ \cos 90 & \cos 90 & \cos 0 \end{bmatrix}$$

$$R_{10} = \begin{bmatrix} \cos\theta & -\sin\theta & 0 \\ \sin\theta & \cos\theta & 0 \\ 0 & 0 & 1 \end{bmatrix}$$