Existing Tests

test_baseplanes

- all functions tested, notable functions: get_base_plane_origin, get_base_plane_normal

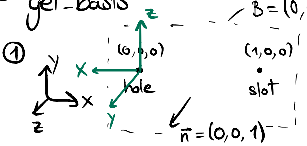
test_pins

- all functions tested

test_pinframe ✓

- get_basis

① $B=(0,0,0,0,\frac{\pi}{2})$

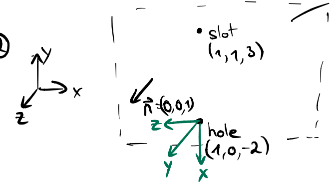


$$P=\begin{pmatrix}-1&0&0\\0&0&1\\0&1&0\end{pmatrix}$$ — pinframe basis

$\sigma=(0,0,0)$

$$\vec{x}_{glob}=P\,\vec{x}_{pin}$$

② $B=(0,0,0,0,\frac{\pi}{2})$



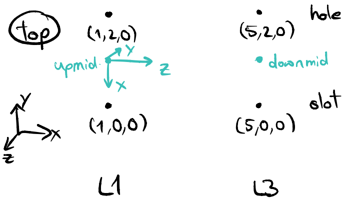
$\sigma=(1,0,0)$

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

test_ballframe ✓

- get_ballframe

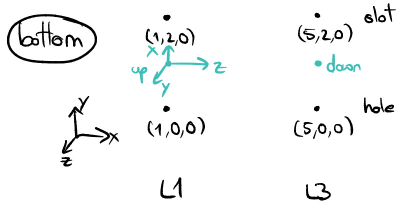
top



$\sigma=(1,1,0)$

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

bottom



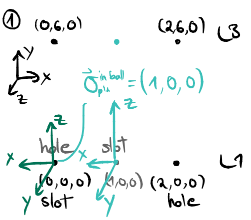
$\sigma=(1,1,0)$

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

test_uchannel ✓

- pin_in_ballframe $\quad B\vec{x}_{ball}=P\vec{x}_{pin}$

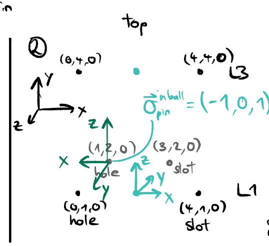
①



$\vec{\sigma}_{pin}^{\,in\,ball}=(1,0,0)$

$$B=\begin{pmatrix}-1&0&0\\0&0&1\\0&1&0\end{pmatrix}\quad P=\begin{pmatrix}-1&0&0\\0&0&1\\0&1&0\end{pmatrix}\quad B^{-1}P=\begin{pmatrix}1&0&0\\0&1&0\\0&0&1\end{pmatrix}$$

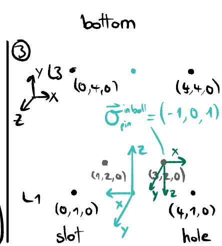
② top



$\vec{\sigma}_{pin}^{\,in\,ball}=(-1,0,1)$

$$B=\begin{pmatrix}1&0&0\\0&0&1\\0&-1&0\end{pmatrix}\quad P=\begin{pmatrix}-1&0&0\\0&0&1\\0&1&0\end{pmatrix}\quad B^{-1}P=\begin{pmatrix}-1&0&0\\0&-1&0\\0&0&1\end{pmatrix}$$

③ bottom

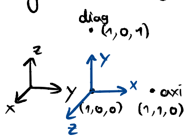


$\vec{\sigma}_{pin}^{\,in\,ball}=(-1,0,1)$

$$B=\begin{pmatrix}-1&0&0\\0&0&1\\0&1&0\end{pmatrix}\quad P=\begin{pmatrix}1&0&0\\0&0&-1\\0&1&0\end{pmatrix}\quad B^{-1}P=\begin{pmatrix}-1&0&0\\0&1&0\\0&0&-1\end{pmatrix}$$

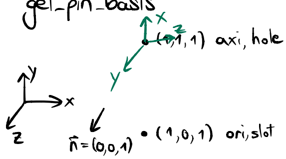
test_fixture ✓

- get_ball_basis



$$B' = \begin{pmatrix} 0 & 0 & 1 \\ 1 & 0 & 0 \\ 0 & 1 & 0 \end{pmatrix} \qquad \sigma = (1,0,0)$$

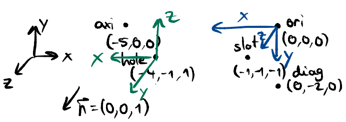
- get_pin_basis



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

$$\sigma = (1,1,0)$$

- get_pin_in_ball



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

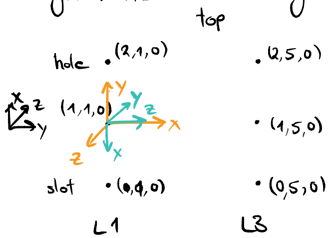
$$P = \begin{pmatrix} -1 & 0 & 0 \\ 0 & 0 & 1 \\ 0 & 1 & 0 \end{pmatrix}$$

$$B'^{-1} P = \begin{pmatrix} 1 & 0 & 0 \\ 0 & 0 & -1 \\ 0 & 1 & 0 \end{pmatrix} \qquad \sigma = (4,1,0)$$

test_mattballframe ✓

- test_get_matt_basis / test_get_basis

top

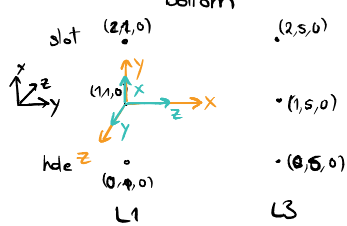


$$M = \begin{pmatrix} 0 & 1 & 0 \\ 1 & 0 & 0 \\ 0 & 0 & -1 \end{pmatrix}$$

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

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

bottom



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

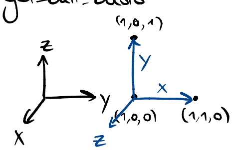
$$B = \begin{pmatrix} 1 & 0 & 0 \\ 0 & 0 & 1 \\ 0 & -1 & 0 \end{pmatrix}$$

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

$M \vec{x}_{Matt} = B \vec{x}_{ball}$ ⟶ get basis in Matt coordinates

test_mattfixture ✓

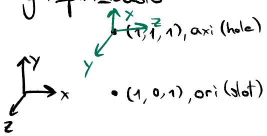
- get_ball_basis



$$B' = \begin{pmatrix} 0 & 0 & 1 \\ 1 & 0 & 0 \\ 0 & 1 & 0 \end{pmatrix}$$

$$\sigma = (1,0,0)$$

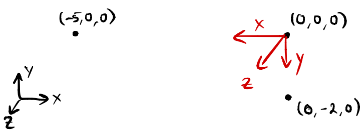
- get_pin_basis



$\sigma = (1,1,0)$

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

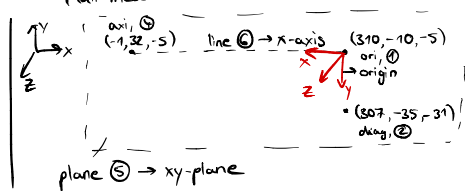
- get_matt_basis



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

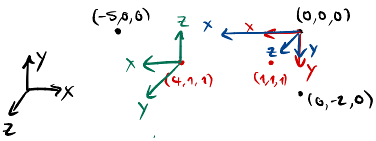
$\sigma = (0,0,0)$

Matt measurement



- get_pin_in_ball / get_ball_in_pin

$$B' \vec{x}_{ball} = P \vec{x}_{pin}$$



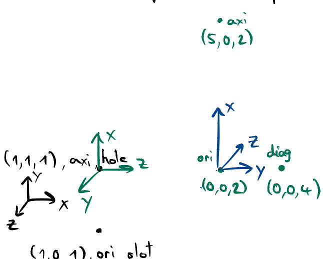
$$B' = \begin{pmatrix} -1 & 0 & 0 \\ 0 & -1 & 0 \\ 0 & 0 & 1 \end{pmatrix} \qquad P = \begin{pmatrix} -1 & 0 & 0 \\ 0 & 0 & 1 \\ 0 & 1 & 0 \end{pmatrix} \qquad M' = \begin{pmatrix} -1 & 0 & 0 \\ 0 & -1 & 0 \\ 0 & 0 & 1 \end{pmatrix}$$

$$B'^{-1} P = \begin{pmatrix} 1 & 0 & 0 \\ 0 & 0 & -1 \\ 0 & 1 & 0 \end{pmatrix}$$ $\sigma = (4,1,0)$ origin of pin in ball

$$P^{-1} B' = \begin{pmatrix} 1 & 0 & 0 \\ 0 & 0 & 1 \\ 0 & -1 & 0 \end{pmatrix}$$ $\sigma = (-4,0,1)$ origin of ball in pin

test_shofixture ✓

- test_ball_in_pin / test_pin_in_ball



$$B' = \begin{pmatrix} 0 & 1 & 0 \\ 1 & 0 & 0 \\ 0 & 0 & -1 \end{pmatrix} \qquad P^{-1} B' = \begin{pmatrix} 1 & 0 & 0 \\ 0 & 0 & -1 \\ 0 & 1 & 0 \end{pmatrix}$$

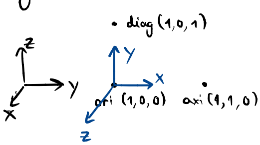
ball in pin $\sigma = (0,0,2)$

$$P = \begin{pmatrix} 0 & 0 & 1 \\ 1 & 0 & 0 \\ 0 & 1 & 0 \end{pmatrix} \qquad B'^{-1} P = \begin{pmatrix} 1 & 0 & 0 \\ 0 & 0 & 1 \\ 0 & -1 & 0 \end{pmatrix}$$

pin in ball $\sigma = (0,-2,0)$

test_sensors ✓

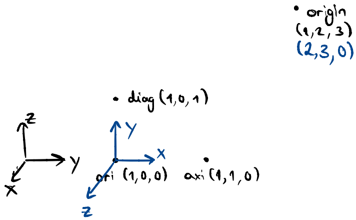
- get_ball_basis



$\sigma = (1,0,0)$

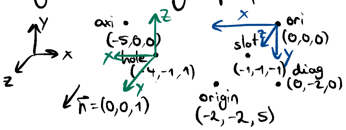
$$B' = \begin{pmatrix} 0 & 0 & 1 \\ 1 & 0 & 0 \\ 0 & 1 & 0 \end{pmatrix}$$

– get_sensor_origin_ballframe



$$\vec{o}_s = \begin{pmatrix}0&0&1\\1&0&0\\0&1&0\end{pmatrix}\left(\begin{pmatrix}1\\2\\3\end{pmatrix}-\begin{pmatrix}1\\0\\0\end{pmatrix}\right) = B'\left(\vec{x}_o^{\,ogp}-\vec{x}_{ori}^{\,ogp}\right)$$

– get_sensor_origin_pinframe



$$B' = \begin{pmatrix}-1&0&0\\0&-1&0\\0&0&1\end{pmatrix} \qquad O=(0,0,0) \qquad \vec{o}_s=(2,2,5)$$

$$P = \begin{pmatrix}-1&0&0\\0&0&1\\0&1&0\end{pmatrix} \qquad O=(-4,-1,1) \qquad \vec{o}_s=(-2,5,-1)$$

$$B'\vec{x}_{ball} = P\vec{x}_{pin}$$

$$P^{-1}B' = \begin{pmatrix}1&0&0\\0&0&1\\0&-1&0\end{pmatrix}$$

ball in pin origin $(-4,0,1)$

$$B'^{-1}\overbrace{\left(\vec{o}_s-\vec{O}_{ball}\right)}^{ogp} = \vec{o}_s^{\,ball}$$

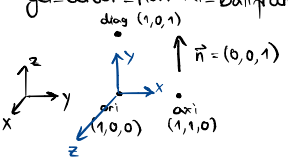
$$P^{-1}B'\left(\vec{o}_s^{\,ball}-\vec{O}_{pin}^{\,inball}\right) = \vec{o}_s^{\,pin}$$

could be diff. B' from above

$$B'^{-1}P = \begin{pmatrix}1&0&0\\0&0&-1\\0&1&0\end{pmatrix}$$

pin in ball origin $(4,1,0)$

– get_sensor_normal_ballframe



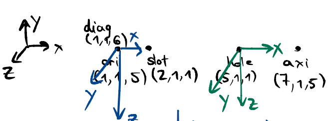
$$O=(1,0,0) \qquad \vec{n}=(0,1,0)$$

$$B' = \begin{pmatrix}0&0&1\\1&0&0\\0&1&0\end{pmatrix} \qquad B'^{-1} = \begin{pmatrix}0&1&0\\0&0&1\\1&0&0\end{pmatrix}$$

$$\vec{n}_{ball} = B'^{-1}\vec{n}_{ogp}$$

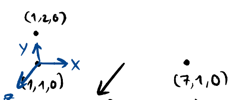
– get_sensor_normal_pinframe

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



$\vec{n}_s=(0,0,1)$

$\vec{n}_s=(0,0,1)$



$\vec{n}_s=(0,0,1)$

$$\vec{n}_s^{\,pin} = \overbrace{P^{-1}B'}^{\text{ball in pin}}\underbrace{B''^{-1}\vec{n}_s}_{\text{sensor normal ballframe}}$$

$$\vec{n}_s^{\,ball2} = B''^{-1}\vec{n}_s$$

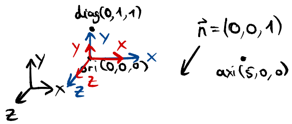
$$\vec{n}_s^{\,ball1} = \vec{n}_s^{\,ball2}$$

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

$$P\,\vec{n}_s^{\,pin} = B'\vec{n}_s^{\,ball1} = B'B''^{-1}\vec{n}_s$$

test_mattsensor ✓

- get_matt_basis / matt_to_ball



$$B' = \begin{pmatrix} 1 & 0 & 0 \\ 0 & 1/\sqrt{2} & -1/\sqrt{2} \\ 0 & 1/\sqrt{2} & 1/\sqrt{2} \end{pmatrix} \qquad \vec{x}^{\,acp} = B' \vec{x}^{\,ball}$$

$$\hat{y} = \frac{1}{\sqrt{2}} \begin{pmatrix} 0 \\ 1 \\ 1 \end{pmatrix} \quad \hat{x} = \begin{pmatrix} 1 \\ 0 \\ 0 \end{pmatrix} \quad \hat{z} = \hat{x} \times \hat{y} = \frac{1}{\sqrt{2}} \begin{pmatrix} 1 \\ 0 \\ 0 \end{pmatrix} \times \begin{pmatrix} 0 \\ 1 \\ 1 \end{pmatrix} = \frac{1}{\sqrt{2}} \begin{pmatrix} 0 \\ -1 \\ 1 \end{pmatrix}$$

$$M' = \begin{pmatrix} 1 & 0 & 0 \\ 0 & 1 & 0 \\ 0 & 0 & 1 \end{pmatrix}$$

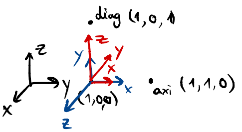
$$M \vec{x}^{\,Matt} = B' \vec{x}^{\,ball} \Rightarrow \vec{x}^{\,ball} = B'^{-1} M \vec{x}^{\,matt}$$

$$B'^{-1} M = \begin{pmatrix} 1 & 0 & 0 \\ 0 & 1/\sqrt{2} & 1/\sqrt{2} \\ 0 & -1/\sqrt{2} & 1/\sqrt{2} \end{pmatrix}$$

- get_sensor_origin_ballframe

$\vec{n}_{ball} = (0,0,1)$ $\quad \vec{o}_s^{\,matt} = (1,2,3)$

$\vec{o}_s^{\,ball} = (1,3,-2)$



$$M' = \begin{pmatrix} 0 & -1 & 0 \\ 1 & 0 & 0 \\ 0 & 0 & 1 \end{pmatrix} \qquad B' = \begin{pmatrix} 0 & 0 & 1 \\ 1 & 0 & 0 \\ 0 & 1 & 0 \end{pmatrix}$$

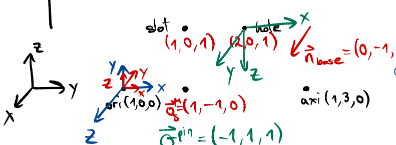
$$M \vec{o}_s^{\,Matt} = B' \vec{o}_s^{\,ball}$$

$$\Rightarrow \vec{o}_s^{\,ball} = B'^{-1} M' \vec{o}_s^{\,Matt} = \begin{pmatrix} 1 & 0 & 0 \\ 0 & 0 & 1 \\ 0 & -1 & 0 \end{pmatrix} \begin{pmatrix} 1 \\ 2 \\ 3 \end{pmatrix} = \begin{pmatrix} 1 \\ 3 \\ -2 \end{pmatrix}$$

matt in ball frame $B'^{-1} M = \begin{pmatrix} 1 & 0 & 0 \\ 0 & 0 & 1 \\ 0 & -1 & 0 \end{pmatrix}$

- get_sensor_origin_pinframe

$\vec{n}_{ball} = (0,0,1)$ $\quad$ diag (1,0,2)



$\vec{o}_s^{\,pin} = (-1,1,1)$

$\vec{o}_s^{\,ball} = (1,0,1)$

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

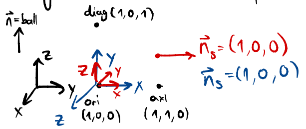
$$B' = \begin{pmatrix} 0 & 0 & 1 \\ 1 & 0 & 0 \\ 0 & 1 & 0 \end{pmatrix} \qquad P^{-1} B' = \begin{pmatrix} 0 & +1 & 0 \\ 1 & 0 & 0 \\ 0 & 0 & -1 \end{pmatrix} \begin{pmatrix} 0 & 0 & 1 \\ 1 & 0 & 0 \\ 0 & 1 & 0 \end{pmatrix} = \begin{pmatrix} +1 & 0 & 0 \\ 0 & 0 & 1 \\ 0 & -1 & 0 \end{pmatrix}$$

$$P = \begin{pmatrix} 0 & 1 & 0 \\ 1 & 0 & 0 \\ 0 & 0 & -1 \end{pmatrix} \qquad \vec{\sigma}^{\,ball} = (2,1,0)$$

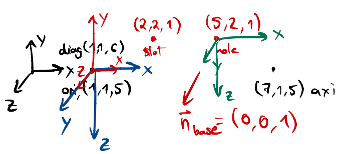
$$B' \vec{o}_s^{\,ball} = M' \vec{o}_s^{\,Matt} \qquad \vec{o}_s^{\,ball} = B'^{-1} M' \vec{o}_s^{\,Matt} \qquad \begin{pmatrix} 1 \\ 0 \\ 1 \end{pmatrix} - \begin{pmatrix} 2 \\ 1 \\ 0 \end{pmatrix} = \begin{pmatrix} -1 \\ -1 \\ 1 \end{pmatrix}$$

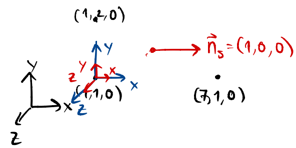
$$\vec{o}_s^{\,pin} = (P^{-1} B') \overbrace{\Big(\underbrace{(B'^{-1} M') \vec{o}_s^{\,Matt}}_{\vec{o}_s^{\,ball} \rightarrow \text{sensor\_origin\_ballframe}} - \vec{\sigma}^{\,pin\ in\ ball} \Big)} = \begin{pmatrix} 1 \\ 1 \\ -1 \end{pmatrix}$$

- get_sensor_normal_ballframe



- get_sensor_normal_pinframe

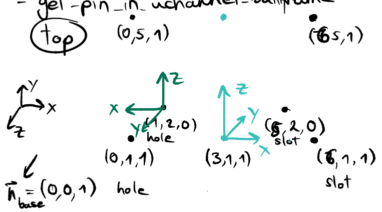




$$\vec{n}_s^{pin} = (1,0,0)$$

test_survey

- get_pin_in_uchannel_ballframe

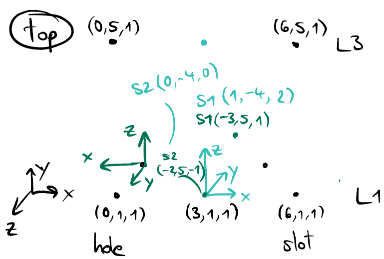


$$P = \begin{pmatrix} -1 & 0 & 0 \\ 0 & 0 & 1 \\ 0 & 1 & 0 \end{pmatrix}$$

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

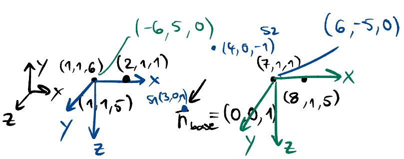
$$B^{-1}P = \begin{pmatrix} -1 & & \\ & -1 & \\ & & 1 \end{pmatrix} \quad \text{basis} = (-2,1,1)$$

- transform_sensor_to_uchannel_ballframe



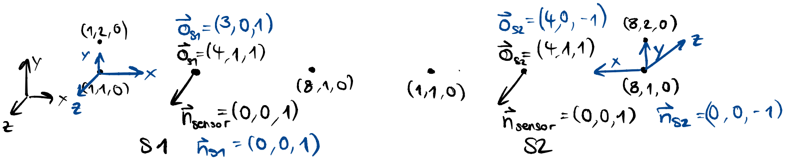
$$P = \begin{pmatrix} -1 & 0 & 0 \\ 0 & 0 & 1 \\ 0 & 1 & 0 \end{pmatrix} \qquad B^{-1}P = \begin{pmatrix} -1 & 0 & 0 \\ 0 & -1 & 0 \\ 0 & 0 & 1 \end{pmatrix} \quad \text{origin } (-2,1,1)$$

$$B = \begin{pmatrix} 1 & 0 & 0 \\ 0 & 0 & 1 \\ 0 & -1 & 0 \end{pmatrix} \qquad \vec{n}_{s_1} = (0,0,1) \quad \vec{n}_{s_2} = (0,0,-1)$$

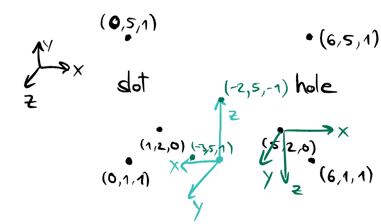


$\vec{n}_{s_1} = (0,0,1)$ $\qquad$ $\vec{n}_{s_2} = (0,0,-1)$

$\vec{o}_{s_1} = (-3,5,1)$ $\qquad$ $\vec{o}_{s_2} = (-2,5,-1)$



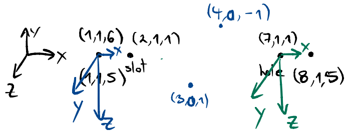
bottom



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

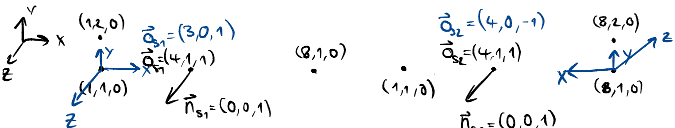
$\vec{n}_{s_1} = (0,0,-1)$ $\qquad$ $\vec{n}_{s_2} = (0,0,1)$

$\vec{o}_{s_1} = (1,4,0)$ $\qquad$ $\vec{o}_{s_2} = (0,4,2)$



$\vec{n}_{s_1} = (0,0,1)$ $\qquad$ $\vec{n}_{s_1} = (0,0,1)$ $\qquad$ $\vec{n}_{s_2} = (0,0,-1)$ $\qquad$ $\vec{n}_{s_2} = (0,0,-1)$

$\vec{o}_{s_1} = (3,0,1)$ $\qquad$ $\vec{o}_{s_1} = (-3,5,1)$ $\qquad$ $\vec{o}_{s_2} = (4,0,-1)$ $\qquad$ $\vec{o}_{s_2} = (-2,5,-1)$



$\vec{o}_{s_1} = (3,0,1)$

$\vec{o}_{s_1} = (4,1,1)$

$\vec{n}_{s_1} = (0,0,1)$

$\vec{n}_{s_1} = (0,0,1)$

$\vec{o}_{s_2} = (4,0,-1)$

$\vec{o}_{s_2} = (4,1,1)$

$\vec{n}_{s_2} = (0,0,1)$

$\vec{n}_{s_2} = (0,0,-1)$