3D Mirror Transformation :

$$P = a + u\cdot b + v\cdot c$$

1. Plane Drawing :

$m := 2 \quad i := 0..m \quad u_i := \frac{i}{m} \quad n := 2 \quad j := 0..n \quad v_j := \frac{j}{n}$

$$P_0 := \begin{pmatrix} 2 \\ 0 \\ 9 \end{pmatrix} \quad P_1 := \begin{pmatrix} 1 \\ 10 \\ 5 \end{pmatrix} \quad P_2 := \begin{pmatrix} 8 \\ 6 \\ 10 \end{pmatrix} \quad n := \frac{(P_1 - P_0) \times (P_2 - P_0)}{\left|(P_1 - P_0) \times (P_2 - P_0)\right|} \quad n = \begin{pmatrix} 0.437 \\ -0.296 \\ -0.849 \end{pmatrix} \quad ns := n$$

$$P_2 := P_0 + n \times (P_1 - P_0) \qquad P_3 := P_2 + (P_1 - P_0)$$

$$P_{i,j} := P_0 + u_i\cdot(P_1 - P_0) + v_j\cdot(P_2 - P_0) \qquad x_{i,j} := (P_{i,j})_0 \quad y_{i,j} := (P_{i,j})_1 \quad z_{i,j} := (P_{i,j})_2$$

2. 3D Part Drawing :

$$pr := \begin{pmatrix} 7 & 2 & -3 & 2 & 7 & 2 & 2 & -3 & 2 & 2 \\ 3 & 8 & 3 & -2 & 3 & 3 & 8 & 3 & 3 & -2 \\ 0 & 0 & 0 & 0 & 0 & 5 & 0 & 0 & 5 & 0 \end{pmatrix}$$

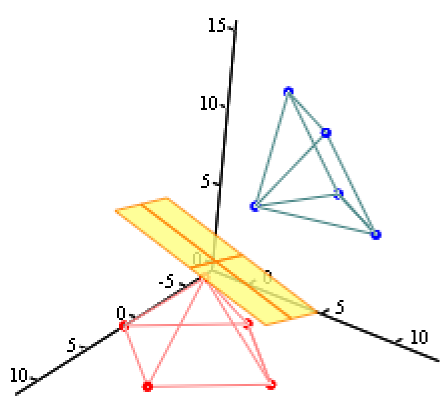
$i := 0..\text{cols}(pr) - 1$

$j := 0..\text{rows}(pr) - 2$

$prs_{j,i} := pr_{j,i}$

3. Mirror of part with respect to plane :

$$p^{\langle i\rangle} := pr^{\langle i\rangle} + 2\cdot n\cdot\left[\left(P_0 - pr^{\langle i\rangle}\right)\cdot n\right]$$



$$\left[\left(pr^T\right)^{\langle 0\rangle}, \left(pr^T\right)^{\langle 1\rangle}, \left(pr^T\right)^{\langle 2\rangle}\right], \left[\left(p^T\right)^{\langle 0\rangle}, \left(p^T\right)^{\langle 1\rangle}, \left(p^T\right)^{\langle 2\rangle}\right], (x, y, z)$$

3. 3D Mirror by using mirror transformation matrix :

$$\theta_x := \operatorname{atan}\left[\frac{n_1}{\sqrt{(n_0)^2 + (n_2)^2}}\right] \qquad \theta_x = -17.213\,\text{deg} \qquad \theta_y := \operatorname{atan}\left(\frac{n_0}{n_2}\right) \qquad \theta_y = -27.255\,\text{deg}$$

$$\text{Mirr} := \begin{pmatrix} 1 & 0 & 0 & 0 \\ 0 & 1 & 0 & 0 \\ 0 & 0 & -1 & 0 \\ 0 & 0 & 0 & 1 \end{pmatrix} \qquad Rx(\theta) := \begin{pmatrix} 1 & 0 & 0 & 0 \\ 0 & \cos(\theta) & -\sin(\theta) & 0 \\ 0 & \sin(\theta) & \cos(\theta) & 0 \\ 0 & 0 & 0 & 1 \end{pmatrix} \qquad Rz(\theta) := \begin{pmatrix} \cos(\theta) & -\sin(\theta) & 0 & 0 \\ \sin(\theta) & \cos(\theta) & 0 & 0 \\ 0 & 0 & 1 & 0 \\ 0 & 0 & 0 & 1 \end{pmatrix}$$

$$T := \begin{pmatrix} 1 & 0 & 0 & P0_0 \\ 0 & 1 & 0 & P0_1 \\ 0 & 0 & 1 & P0_2 \\ 0 & 0 & 0 & 1 \end{pmatrix} \qquad T1 := \begin{pmatrix} 1 & 0 & 0 & -P0_0 \\ 0 & 1 & 0 & -P0_1 \\ 0 & 0 & 1 & -P0_2 \\ 0 & 0 & 0 & 1 \end{pmatrix} \qquad Ry(\theta) := \begin{pmatrix} \cos(\theta) & 0 & \sin(\theta) & 0 \\ 0 & 1 & 0 & 0 \\ -\sin(\theta) & 0 & \cos(\theta) & 0 \\ 0 & 0 & 0 & 1 \end{pmatrix}$$

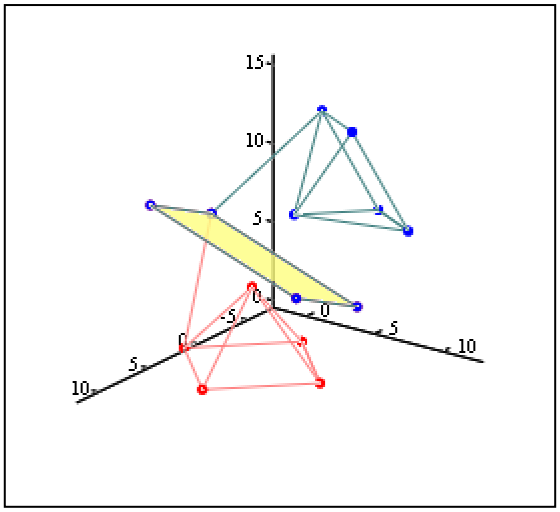
$$n := \frac{P1 - P0}{|P1 - P0|} \qquad n = \begin{pmatrix} -0.092 \\ 0.925 \\ -0.37 \end{pmatrix} \qquad \begin{pmatrix} n_x \\ n_y \\ n_z \end{pmatrix} := n \qquad |n| = 1$$

$$c(\theta) \equiv \cos(\theta) \qquad s(\theta) \equiv \sin(\theta)$$

$$pr := \begin{pmatrix} 7 & 2 & -3 & 2 & 7 & 2 & 2 & -3 & 2 & 2 & P0_0 & P1_0 & P3_0 & P2_0 & P0_0 \\ 3 & 8 & 3 & -2 & 3 & 3 & 8 & 3 & 3 & -2 & P0_1 & P1_1 & P3_1 & P2_1 & P0_1 \\ 0 & 0 & 0 & 0 & 0 & 5 & 0 & 0 & 5 & 0 & P0_2 & P1_2 & P3_2 & P2_2 & P0_2 \\ 1 & 1 & 1 & 1 & 1 & 1 & 1 & 1 & 1 & 1 & 1 & 1 & 1 & 1 & 1 \end{pmatrix}$$

$$R(\theta) := \begin{bmatrix} n_x{}^2\cdot(1 - c(\theta)) + c(\theta) & n_x\cdot n_y\cdot(1 - c(\theta)) - n_z\cdot s(\theta) & n_x\cdot n_z\cdot(1 - c(\theta)) + n_y\cdot s(\theta) & 0 \\ n_x\cdot n_y\cdot(1 - c(\theta)) + n_z\cdot s(\theta) & n_y{}^2\cdot(1 - c(\theta)) + c(\theta) & n_y\cdot n_z\cdot(1 - c(\theta)) - n_x\cdot s(\theta) & 0 \\ n_x\cdot n_z\cdot(1 - c(\theta)) - n_y\cdot s(\theta) & n_y\cdot n_z\cdot(1 - c(\theta)) - n_x\cdot s(\theta) & n_z{}^2\cdot(1 - c(\theta)) + c(\theta) & 0 \\ 0 & 0 & 0 & 1 \end{bmatrix}$$

$$R\left(\frac{\pi}{3}\right) = \begin{pmatrix} 0.504 & 0.278 & 0.818 & 0 \\ -0.363 & 0.927 & -0.091 & 0 \\ -0.784 & -0.091 & 0.568 & 0 \\ 0 & 0 & 0 & 1 \end{pmatrix} \qquad p := T\cdot\left(Ry(\theta_y)\cdot Rx(\theta_x)\right)\cdot \text{Mirr}\cdot Rx(-\theta_x)\cdot Ry(-\theta_y)\cdot T1\cdot pr$$



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