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Parte I

$$A = [2, 1, 3] \text{ factor } 1.43$$

$$\underline{\text{Escala}} = \begin{bmatrix} 1.43 & 0 & 0 & 0 \\ 0 & 1.43 & 0 & 0 \\ 0 & 0 & 1.43 & 0 \\ 0 & 0 & 0 & 1 \end{bmatrix} \begin{bmatrix} 2 \\ 1 \\ 3 \\ 1 \end{bmatrix}$$

$$\underline{\text{Escala}} = \begin{bmatrix} 2.86 \\ 1.43 \\ 4.29 \\ 1 \end{bmatrix}$$

$$B = [4, 3, 1]$$

$$Q = \begin{bmatrix} 1 & 0 & 0 & 4 \\ 0 & 1 & 0 & 3 \\ 0 & 0 & 1 & 1 \\ 0 & 0 & 0 & 1 \end{bmatrix} \begin{bmatrix} 2.86 \\ 1.43 \\ 4.29 \\ 1 \end{bmatrix} = \begin{bmatrix} 6.86 \\ 4.43 \\ 5.29 \\ 1 \end{bmatrix}$$

Traslado

$$(\equiv [3, 2, 4])$$

Trasladar
al
origen

$$= \begin{bmatrix} 1 & 0 & 0 & -6.86 \\ 0 & 1 & 0 & -4.43 \\ 0 & 0 & 1 & -5.29 \\ 0 & 0 & 0 & 1 \end{bmatrix} \begin{bmatrix} 3 \\ 2 \\ 4 \\ 1 \end{bmatrix} = \begin{bmatrix} -3.86 \\ -2.43 \\ -1.29 \\ 1 \end{bmatrix}$$

Rotación

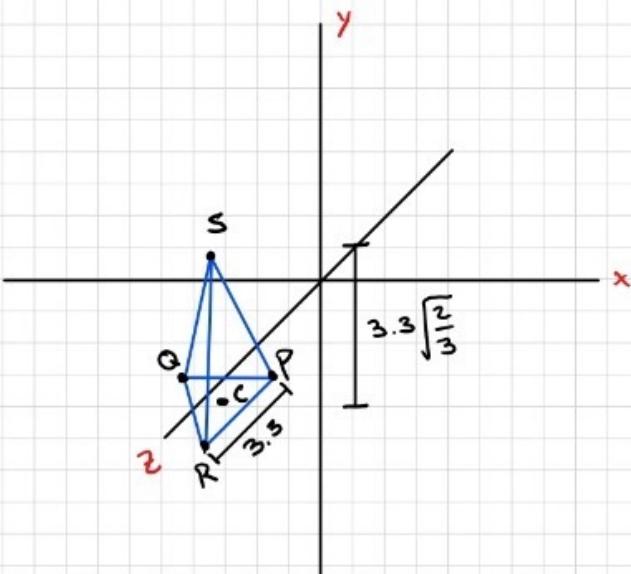
$$R_x(45^\circ) = \begin{bmatrix} 1 & 0 & 0 & 0 \\ 0 & \cos 45^\circ & -\sin 45^\circ & 0 \\ 0 & \sin 45^\circ & \cos 45^\circ & 0 \\ 0 & 0 & 0 & 1 \end{bmatrix} \begin{bmatrix} -3.86 \\ -2.43 \\ -1.29 \\ 1 \end{bmatrix}$$

$$= \begin{bmatrix} -3.86 \\ -1.72 + 0.91 \\ -1.72 - 0.91 \\ 1 \end{bmatrix} = \begin{bmatrix} -3.86 \\ -0.806 \\ -2.63 \\ 1 \end{bmatrix}$$

$$\text{Trasladar al pivote} = \begin{bmatrix} 1 & 0 & 0 & 6.86 \\ 0 & 1 & 0 & 4.43 \\ 0 & 0 & 1 & 5.29 \\ 0 & 0 & 0 & 1 \end{bmatrix} \begin{bmatrix} -3.86 \\ -0.806 \\ -2.63 \\ 1 \end{bmatrix} = \begin{bmatrix} -3.86 + 6.86 \\ -0.806 + 4.43 \\ -2.63 + 5.29 \\ 1 \end{bmatrix}$$

$$= \begin{bmatrix} 3 \\ 3.62 \\ 2.66 \\ 1 \end{bmatrix}$$

Parte 2



$$C = (-1.812, -6.824, 5.247)$$

C siendo el baricentro de la base

$$P = (Q_x + 3.3, -6.824, Q_z)$$

$$Q = (Q_x, Q_y, Q_z)$$

$$R = (R_x, R_y, R_z)$$

$$C = \left(\frac{P_x + Q_x + R_x}{3}, -6.824, \frac{P_z + Q_z + R_z}{3} \right)$$

Sustituyendo

$$C = \left(\frac{Q_x + 3.3 + Q_x + R_x}{3}, -6.824, \frac{Q_z + Q_z + R_z}{3} \right)$$

Al igualar con los valores dados de C

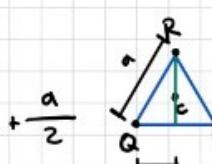
$$\frac{2Q_x + R_x + 3.3}{3} = -1.812$$

$$\frac{2Q_z + R_z}{3} = 5.247$$

$$\Rightarrow \begin{cases} 2Q_x + R_x = -8.736 \\ 2Q_z + R_z = 15.741 \end{cases}$$

$$R_x = Q_x + \frac{a}{2}$$

$$R_z = Q_z + \frac{\sqrt{3}}{2}a$$



$$\begin{aligned} \sqrt{a^2 + \left(\frac{a}{2}\right)^2} &= \sqrt{\frac{4a^2}{4} + \frac{a^2}{4}} \\ &= \sqrt{\frac{3a^2}{4}} \\ &= \frac{\sqrt{3}}{2}a \end{aligned}$$

$$2Q_x + \left(Q_x + \frac{a}{2}\right) = -8.736 \Rightarrow Q_x = \frac{-8.736 - \frac{3.3}{2}}{3} = -3.462$$

$$2Q_z + \left(Q_z + \frac{\sqrt{3}}{2}a\right) = 15.741 \Rightarrow Q_z = \frac{15.741 - \frac{\sqrt{3}}{2}(3.3)}{3} = 4.294$$

Finalmente vértices de la pirámide

$$Q = (-3.462, -6.824, 4.294)$$

$$P = (-3.462 + 3.3, -6.824, 4.294) = (-0.162, -6.824, 4.294)$$

$$R = \left(-3.462 + \frac{3.3}{2}, -6.824, 4.294 + \frac{\sqrt{3}}{2}(3.3)\right) = (-1.812, -6.824, 7.151)$$

$$S = \left(-1.812, -6.824 + 3.3\sqrt{\frac{2}{3}}, 5.247\right) = (-1.812, -4.129, 5.247)$$

- Nueva posición de los vehículos cuando la pirámide es rotada respecto al eje Y por -15° . El pivote es el centroide de la pirámide.

Centroide:

$$G = \left(\frac{(-3.462 + (-0.162) + (-1.812) + (-1.812))}{4}, \frac{(-6.824 + (-6.824) + (-6.824) + (-4.179))}{4}, \frac{(4.294 + 4.294 + 7.151 + 5.247)}{4} \right)$$

$$G = \left(\frac{-7.248}{4}, \frac{-24.601}{4}, \frac{20.986}{4} \right) = (-1.812, -6.15025, 5.25)$$

Trasladando al origen Q:

$$T = \begin{bmatrix} 1 & 0 & 0 & 1.812 \\ 0 & 1 & 0 & 6.150 \\ 0 & 0 & 1 & -5.25 \\ 0 & 0 & 0 & 1 \end{bmatrix} \begin{bmatrix} -3.462 \\ -6.824 \\ 4.294 \\ 1 \end{bmatrix} = \begin{bmatrix} -1.65 \\ -0.644 \\ -0.956 \\ 1 \end{bmatrix}$$

Trasladando al origen P :

$$T = \begin{bmatrix} 1 & 0 & 0 & 1.812 \\ 0 & 1 & 0 & 6.150 \\ 0 & 0 & 1 & -5.25 \\ 0 & 0 & 0 & 1 \end{bmatrix} \begin{bmatrix} -0.162 \\ -6.824 \\ 4.294 \\ 1 \end{bmatrix} = \begin{bmatrix} 1.65 \\ -0.644 \\ -0.956 \\ 1 \end{bmatrix}$$

Trasladando al origen R :

$$T = \begin{bmatrix} 1 & 0 & 0 & 1.812 \\ 0 & 1 & 0 & 6.150 \\ 0 & 0 & 1 & -5.25 \\ 0 & 0 & 0 & 1 \end{bmatrix} \begin{bmatrix} -1.812 \\ -6.824 \\ 7.151 \\ 1 \end{bmatrix} = \begin{bmatrix} 0 \\ -0.644 \\ 1.901 \\ 1 \end{bmatrix}$$

Trasladando al origen S :

$$T = \begin{bmatrix} 1 & 0 & 0 & 1.812 \\ 0 & 1 & 0 & 6.150 \\ 0 & 0 & 1 & -5.25 \\ 0 & 0 & 0 & 1 \end{bmatrix} \begin{bmatrix} -1.812 \\ -4.129 \\ 5.247 \\ 1 \end{bmatrix} = \begin{bmatrix} 0 \\ 2.021 \\ 0 \\ 1 \end{bmatrix}$$

$$R_y(-15) = \begin{bmatrix} \cos -15 & 0 & \sin -15 & 0 \\ 0 & 1 & 0 & 0 \\ -\sin -15 & 0 & \cos -15 & 0 \\ 0 & 0 & 0 & 1 \end{bmatrix} \begin{bmatrix} -1.65 \\ -0.644 \\ -0.956 \\ 1 \end{bmatrix} = \begin{bmatrix} \cos -15 \cdot (-1.65) + \sin -15 (-0.956) \\ -0.644 \\ -\sin -15 \cdot (-1.65) + \cos -15 (-0.956) \\ 1 \end{bmatrix}$$

$$= \begin{bmatrix} -1.346 \\ -0.644 \\ -1.35 \\ 1 \end{bmatrix}$$

$$R_y(-15) = \begin{bmatrix} \cos -15 & 0 & \sin -15 & 0 \\ 0 & 1 & 0 & 0 \\ -\sin -15 & 0 & \cos -15 & 0 \\ 0 & 0 & 0 & 1 \end{bmatrix} \begin{bmatrix} 1.65 \\ -0.644 \\ -0.956 \\ 1 \end{bmatrix} = \begin{bmatrix} \cos -15 (1.65) + \sin -15 (-0.956) \\ -0.644 \\ -\sin -15 (1.65) + \cos -15 (-0.956) \\ 1 \end{bmatrix}$$

$$= \begin{bmatrix} 1.841 \\ -0.644 \\ -0.496 \\ 1 \end{bmatrix}$$

$$R_y(-15) = \begin{bmatrix} \cos -15 & 0 & \sin -15 & 0 \\ 0 & 1 & 0 & 0 \\ -\sin -15 & 0 & \cos -15 & 0 \\ 0 & 0 & 0 & 1 \end{bmatrix} \begin{bmatrix} 0 \\ -0.644 \\ 1.901 \\ 1 \end{bmatrix} = \begin{bmatrix} \sin -15 (1.901) \\ -0.644 \\ \cos -15 (1.901) \\ 1 \end{bmatrix}$$

$$= \begin{bmatrix} -0.492 \\ -0.644 \\ 1.836 \\ 1 \end{bmatrix}$$

$$R_y(-15) = \begin{bmatrix} \cos -15 & 0 & \sin -15 & 0 \\ 0 & 1 & 0 & 0 \\ -\sin -15 & 0 & \cos -15 & 0 \\ 0 & 0 & 0 & 1 \end{bmatrix} \begin{bmatrix} 0 \\ 2.021 \\ 0 \\ 1 \end{bmatrix} = \begin{bmatrix} 0 \\ 2.021 \\ 0 \\ 1 \end{bmatrix}$$

Trasladando Q

$$T = \begin{bmatrix} 1 & 0 & 0 & -1.812 \\ 0 & 1 & 0 & -6.150 \\ 0 & 0 & 1 & 5.25 \\ 0 & 0 & 0 & 1 \end{bmatrix} \begin{bmatrix} -1.346 \\ -0.644 \\ -1.35 \\ 1 \end{bmatrix} = \begin{bmatrix} -3.158 \\ -6.824 \\ 3.9 \\ 1 \end{bmatrix}$$

Trasladando P

$$T = \begin{bmatrix} 1 & 0 & 0 & -1.812 \\ 0 & 1 & 0 & -6.150 \\ 0 & 0 & 1 & 5.25 \\ 0 & 0 & 0 & 1 \end{bmatrix} \begin{bmatrix} 1.841 \\ -0.644 \\ -0.496 \\ 1 \end{bmatrix} = \begin{bmatrix} 0.029 \\ -6.824 \\ 4.754 \\ 1 \end{bmatrix}$$

Traslendendo R

$$T = \begin{bmatrix} 1 & 0 & 0 & -1.812 \\ 0 & 1 & 0 & -6.150 \\ 0 & 0 & 1 & 5.25 \\ 0 & 0 & 0 & 1 \end{bmatrix} \begin{bmatrix} -0.492 \\ -0.644 \\ 1.836 \\ 1 \end{bmatrix} = \begin{bmatrix} -2.304 \\ -6.824 \\ 7.086 \\ 1 \end{bmatrix}$$

Traslendendo S

$$T = \begin{bmatrix} 1 & 0 & 0 & -1.812 \\ 0 & 1 & 0 & -6.150 \\ 0 & 0 & 1 & 5.25 \\ 0 & 0 & 0 & 1 \end{bmatrix} \begin{bmatrix} 0 \\ 2.021 \\ 0 \\ 1 \end{bmatrix} = \begin{bmatrix} -1.812 \\ -4.129 \\ 5.25 \\ 1 \end{bmatrix}$$