$$M = \begin{bmatrix} -f_x r_{11} + o_x r_{31} & -f_x r_{12} + o_x r_{32} & -f_x r_{13} + o_x r_{33} & -f_x T_x + o_x T_z \\ -f_y r_{21} + o_y r_{31} & -f_y r_{22} + o_y r_{32} & -f_y r_{23} + o_y r_{33} & -f_y T_y + o_y T_z \\ r_{31} & r_{32} & r_{33} & T_z \end{bmatrix}$$

$\hat{M} = \gamma M$ what is $|\gamma|$ $\sqrt{r_{31}^2 + r_{32}^2 + r_{33}^2} = |\gamma|$

computed rotation matrix R, rows and columns are unit vectors and their dot product is zero

and we know $T_z > 0$ since camera is in front so, compute γ and so find original M

$q_1 = [m_{11} \; m_{12} \; m_{13}]$

$q_2 = [m_{21} \; m_{22} \; m_{23}]$

$q_3 = [m_{31} \; m_{32} \; m_{33}]$

$\begin{bmatrix} \bar{r}_1 \\ \bar{r}_2 \\ \bar{r}_3 \end{bmatrix}$

$r_1 \cdot r_1 \quad r_2 \cdot r_2 \quad r_3 \cdot r_3$

$= |r_1|^2 = |r_2|^2 = |r_3|^2 = 1$

$= \bar{r}_1 \cdot \bar{r}_2 = \bar{r}_1 \cdot \bar{r}_3 = \bar{r}_2 \cdot \bar{r}_3 = 0$

by characteristics of rotation matrix

$q_1 q_3$

$-f_x r_{31} r_{11} + o_x r_{31}^2 - f_x r_{12} r_{32} + o_y r_{32}^2 - f_x r_{23} r_{33} + o_y r_{33}^2$

$-f_x\underbrace{(r_{31} r_{11} + r_{32} r_{12} + r_{33} r_{23})}_{0} + o_x\overbrace{(r_{31}^2 + r_{32}^2 + r_{33}^2)}^{1}$

$\bar{q}_1 \cdot \bar{q}_3 = o_x$ similarly $\bar{q}_2 \cdot \bar{q}_3 = o_y$