10/5/13

ROBOVISION
ASSIGNMENT #2

RAGHAVENDRA SRIRAM
1000854840.

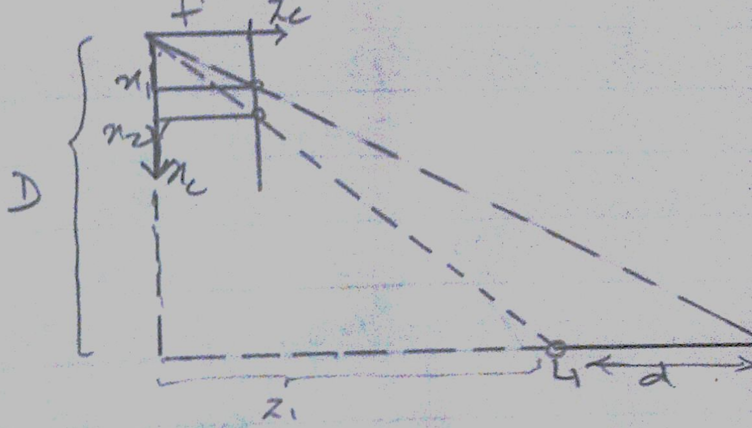
Ex 1 $u_1 = [u_1, v_1]^T = [470, 270]^T$

$u_2 = [395, 255]^T$

$u_0 = (320, 240)$ pix

$f = 10$ mm

$K_u = K_v = 10^4$ pix/m.



Now,

L_1 :- $f k_u \frac{D}{z_1} + u_0 = u$

$f k_v \frac{y_1}{z_1} + v_0 = v_1$

L_2 :- $f k_u \frac{D}{z+d} + u_0 = u_2$

$f k_v \frac{y_2}{z_1+d} + v_0 = v_2$

$\Rightarrow (10^{-2} \times 10^4) \frac{D}{z_1} + 320 = 470$

$100 \times \frac{D}{} = 150 \therefore \boxed{D = 1.5 z_1}$

$\therefore$ Now,

$$10^2\left(\frac{D}{2/3\,D+1}\right) + 320 = 395$$

$$10^2\left(\frac{3D}{2D+3}\right) = 25$$

$\therefore$ $D = 0.5D + 0.75$

$\boxed{D = 1.5m}$ & from above,

$\boxed{Z_1 = 1m}$

Q2 a) $fk_u = fk_v = 1000.$

$^Lx = [0.045, -0.01, 1]^T$

$d = 0.09m$

we know

$$s\begin{bmatrix} u \\ v \\ 1 \end{bmatrix} = \begin{bmatrix} fk_u & 0 & u_0 \\ 0 & fk_v & v_0 \\ 0 & 0 & 1 \end{bmatrix}\begin{bmatrix} X_2 \\ Y_2 \\ Z_2 \end{bmatrix}$$

$$= \begin{bmatrix} 1000 & 0 & 300 \\ 0 & 1000 & 300 \\ 0 & 0 & 1 \end{bmatrix}\begin{bmatrix} 0.045 \\ -0.01 \\ 1 \end{bmatrix}$$

$$= \begin{bmatrix} 345 \\ 290 \\ 1 \end{bmatrix}$$

$\therefore \boxed{^Lu = [345; 290]^T}$

$$ {}^{R}X = {}^{R}_{L}R \, {}^{L}X + {}^{R}_{L}t $$

$$ {}^{R}_{L}R = I $$ [AS NO ROTATION IN L & R FRAMES]

$$ \because \; {}^{R}_{L}R = I, $$

$$ {}^{R}X = {}^{L}X + {}^{R}_{L}T $$

$$ = \begin{bmatrix} 0.045 \\ -0.01 \\ 1 \end{bmatrix} + \begin{bmatrix} -0.09 \\ 0 \\ 0 \end{bmatrix} $$

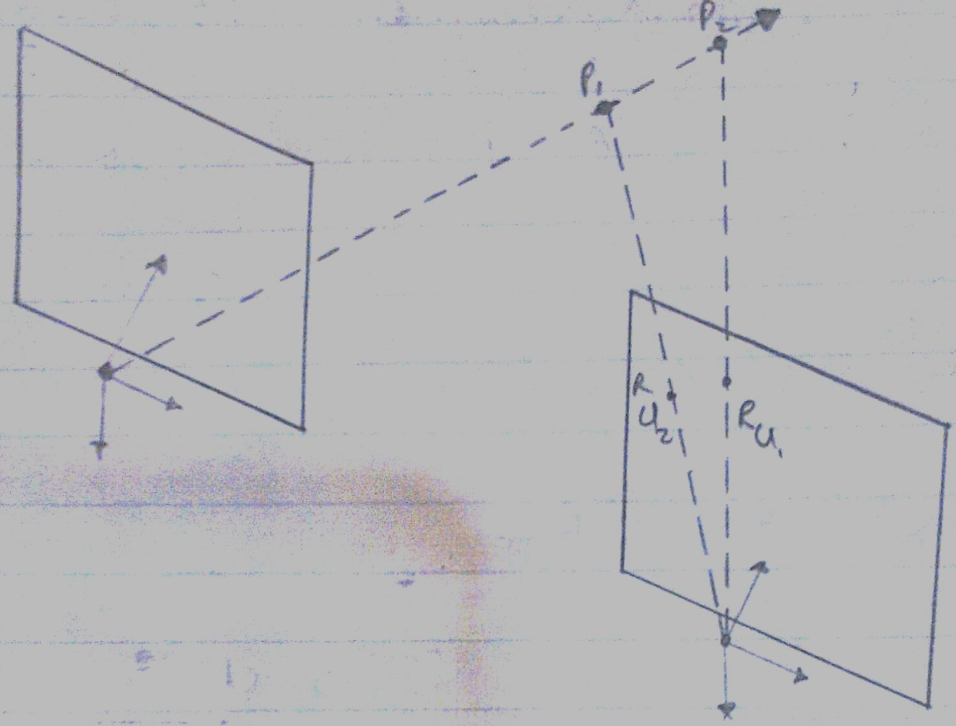
$$ \therefore \; {}^{R}X = \begin{bmatrix} -0.045 \\ -0.01 \\ 1 \end{bmatrix} $$

$$ {}^{R}u = \begin{bmatrix} fk_u & 0 & u_0 \\ 0 & fk_v & v_0 \\ 0 & 0 & 1 \end{bmatrix} \begin{bmatrix} X_R \\ Y_R \\ Z_R \end{bmatrix} $$

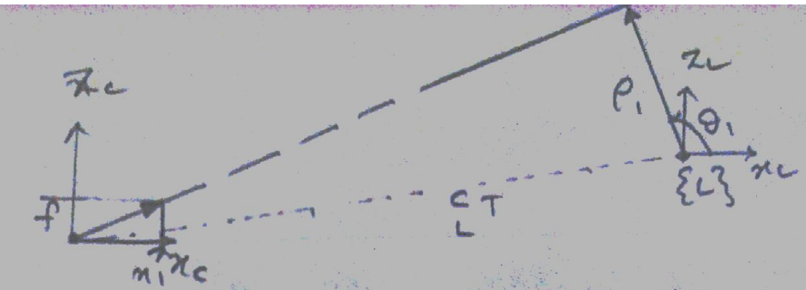
$$ = \begin{bmatrix} 1000 & 0 & 300 \\ 0 & 1000 & 300 \\ 0 & 0 & 1 \end{bmatrix} \begin{bmatrix} -0.045 \\ -0.01 \\ 1 \end{bmatrix} $$

$$ s \begin{bmatrix} u_R \\ v_R \\ 1 \end{bmatrix} = \begin{bmatrix} 355 \\ 290 \\ 1 \end{bmatrix} \quad \therefore \; \boxed{{}^{R}u = [355, 290} $$

(b)



If the left frame can view only 1 point while on the right plane, 2 points (P_1, P_2) are visible, then it implies that the two points are in a straight line to the point of view of the left frame. i.e. all three points are collinear.
Thus to tell them apart, the horizontal components, $^R u_1$ & $^R u_2$ should be different.
But since they are visible as one on the left plane, they can't be differentiated

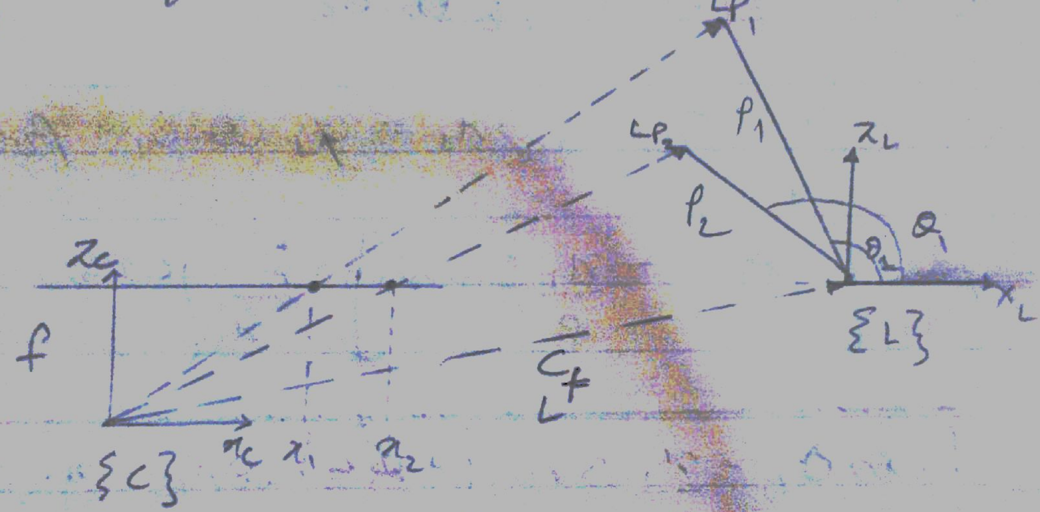


Q3 (a) -

In the given diagram, the frame {L} does not rotate wrt to the camera frame. Thus the points δ_1, θ_1 & x_1 are constant in both positions & only translation ${}^C_L T$ change can be seen.

Thus, we cannot determine the position laser frame wrt to the camera

(b)



The expression can be written as:

$$\lambda_1 \begin{bmatrix} x_1 \\ f \end{bmatrix} = {}^C_L T + \rho_1 \begin{bmatrix} \cos\theta_1 \\ \sin\theta_1 \end{bmatrix}$$

$$\lambda_2 \begin{bmatrix} x_2 \\ f \end{bmatrix} = {}^C_L T + \rho_2 \begin{bmatrix} \cos\theta_2 \\ \sin\theta_2 \end{bmatrix}$$

$$\lambda_1 x_1 = T_x + \rho_1 \cos\theta_1 \quad (1)$$
$$\lambda_1 f = T_f + \rho_1 \sin\theta_1 \quad (2)$$
$$\lambda_2 x_2 = T_x + \rho_2 \cos\theta_2 \quad (3)$$
$$\lambda_2 f = T_f + \rho_2 \sin\theta_2 \quad (4)$$

from the above ② - ④.

$$\boxed{(\lambda_1 - \lambda_2) f = \frac{\rho_1 \sin\theta_1 - \rho_2 \sin\theta_2}{f}}$$

Now x_1 ① - ③

$$\lambda_1 x_1 - \lambda_2 x_2 = \rho_1 \cos\theta_1 + \rho_2 \sin\theta_2$$

$$\lambda_2 x_1 + \left(\frac{\rho_1 \sin\theta_1 - \rho_2 \sin\theta_2}{f}\right) x_1 = \rho_1 \cos\theta_1 + \rho_2 \cos\theta_2$$

$$\lambda_2 x_1 = \frac{\rho_1}{x_1}\left[\cos\theta_1 - \frac{x_1}{f}\sin\theta_1\right] + \frac{\rho_2}{x_1}\left[\cos\theta_2 + \frac{x_1}{f}\sin\theta_2\right]$$

$$\therefore \boxed{\lambda_2 = \frac{\rho_1}{x_1}\left[\cos\theta_1 - \frac{x_1}{f}\sin\theta_1\right] + \frac{\rho_2}{x_1}\left[\cos\theta_2 + \frac{x_1}{f}\sin\theta_2\right]}$$

$$\approx \boxed{\lambda_1 - \frac{\rho_1}{x_1}\left[\cos\theta_1 - \frac{x_1}{f}\sin\theta_1\right) + \frac{\rho_2}{x_1}\left[\cos\theta_2 + \frac{x_1}{f}\sin\theta_2\right] + \left[\frac{\rho_1 \sin\theta_1 - \rho_2 \sin\theta_2}{f}\right]}$$

Substituting the above results in the first 2 equations we can compute ζ_T