CS 512 HW5
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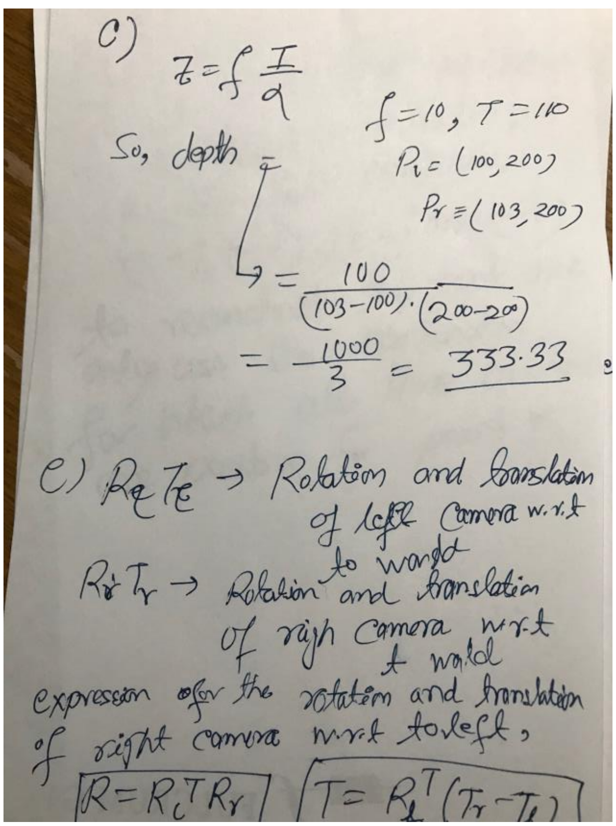
1)

a)

Sparse and dense matching algorithms give different results on narrow and wide baseline stereo pairs. Sparse matching algorithms are used to establish a set of robust matches between an image pair. These sparse matches may then be used to compute the epipolar geometry, using techniques such as the RANSAC (random sampling) method. Dense matching algorithms are used to find matches for all points in the images. The search for a match is constrained by the epipolar geometry derived from the set of sparse matches



c) $Z = f\frac{T}{d}$

$f = 10$, $T = 110$

$P_l = (100, 200)$

$P_r = (103, 200)$

So, depth $= \frac{100}{(103-100)\cdot(200-200)}$

$= \frac{1000}{3} = \underline{333.33}$

e) $R_l T_l \rightarrow$ Rotation and translation of left camera w.r.t to world

$R_r T_r \rightarrow$ Rotation and translation of righ camera w.r.t t world

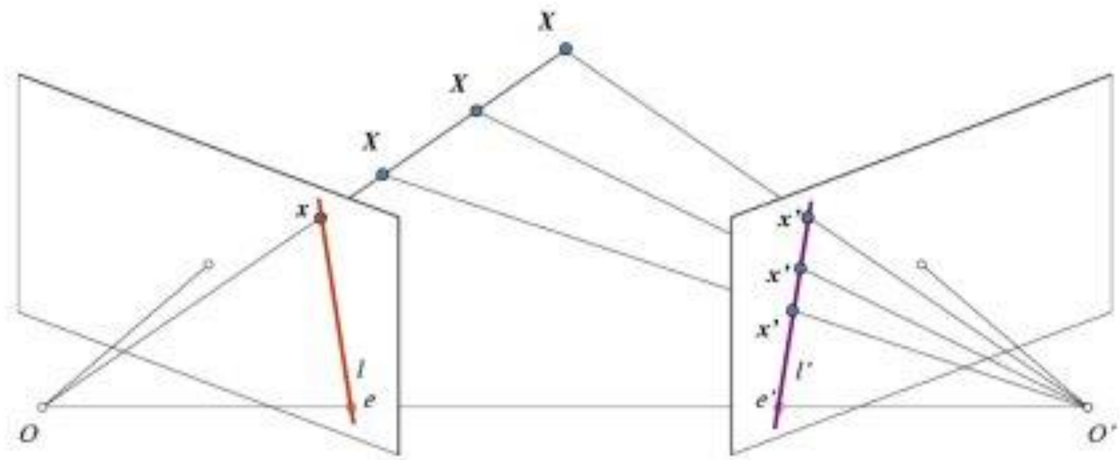
expression for the rotation and translation of right camera w.r.t to left,

$\boxed{R = R_l^T R_r}$ $\boxed{T = R_l^T (T_r - T_l)}$

d)**Ambiguity Problem:**

The point ambiguity owing to the ambiguous local appearances of image points is the one of the main causes making the stereo problem difficult. Under the point ambiguity, local similarity measures are easy to be ambiguous and this results in false matches in ambiguous regions.

2)
a)



From the setup given above, you can see that projection of right camera O' is seen on the left image at the point,e It is called the **epipole**. Epipole is the point of intersection of line through camera centers and the image planes. Similarly, epipole of the left camera. In some cases, you won't be able to locate the epipole in the image, they may be outside the image (which means, one camera doesn't see the other).

b) Essential Matrix (E) ⇒

$$\boxed{E = R^T[T]_x}$$

(3X3 matrix)

Epipolar constraint equation using essential matrix E, given P_l, P_r

$$P_r^T E P_l = 0$$

$$\boxed{P_r^T E P_l = 0}$$

c) Fundamental matrix (F) ⇒

$$F = K_r E K_l$$

Epipolar constraint equation using F, given P_l, P_r ⇒

$$\boxed{P_r^T F P_l = 0}$$

d)

Both Essential and Fundamental matrix are rank 2 matrix as both these matrices have T in them which is a rank 2 matrix.

e) Corresponding right epipole line,

FP_t

where,
F = Fundamental matrix
and t = line right epipolar

f) Corresponding left epipole line,

FP_r

F = fundamental matrix
r = left epipolar line

g)

Weak calibration method requires there to be a set of known correspondences beforehand in order to calculate the fundamental matrix. This is widely used to determine a fundamental matrix which can then be used to find epipolar lines. These lines can then be used in pre-existing algorithms by rectifing the stereo images so that the scan lines are the epipolar lines as well.

h) $P_l = (100, 200)\ P'$

$P_r = (50, 100)\ (P)$

First line in matrix will be:

$$\begin{bmatrix} x_1 x' & x_1 y_1' & x_1 & y_1 x_1' & y_1 x_1' & y_1 y_1' & y_1 & x_1' & y_1' & 1 \\ 1 & . & 1 & 1 & 1 & 1 & 1 & & & \\ 1 & 1 & 1 & 1 & & & & & & \end{bmatrix}$$

First row ⇒

$$= \begin{bmatrix} 5000 & 10000 & 50 & 10000 & 20000 & 100 & 100 & 200 \end{bmatrix}$$

j) To recover epipole from fundamental matrin →

Right epipole (e_r) is left null space of fundamental matrin F. where left null Space of F is the last column of U ($F = U \Delta V^T$)

for the left epipole

$$P_r^T F e_l = 0 \Rightarrow \boxed{F e_l = 0}$$

left epipole e_l is the right null space of F which is the right column of V ($F = U \Delta V^T$)

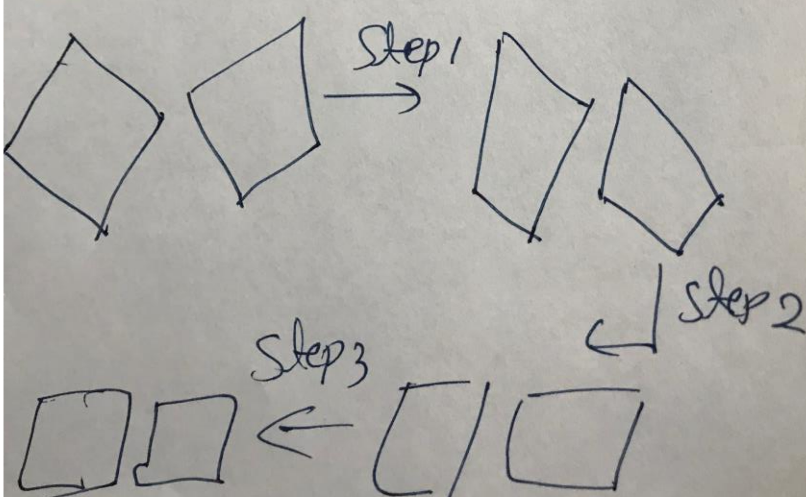
3)

5) (a) Rectifying Sterea pair ⇒

Step1: align right with left image that means they shauld have same orientation.

Step2: Align both images with baseline.

Step3: Make w planer



before starting the process we need to move points to camera coordinates.

$$R_{lef\text{-}rol} = K_l^{*} R_{rec} (K^{*})^{-1}$$

$$R_{right\text{-}rol} = K_r^{*} R_{rec} R^{T} (K_r^{*})^{-1}$$

b) Reconstruction Approaches ⇒

(a) Euclidean Reconstruction

(b) Reconstruction up to unknown 3D directive map

c) given $R \Rightarrow$ rotation

$T \rightarrow$ translation

P_l and P_r $\rightarrow$ left and right coordinates

to solve (a, b, c) we need to solve,

$$\begin{bmatrix} a \\ b \\ c \end{bmatrix} = A^{-1} T$$

where, $A = \begin{bmatrix} P_l & -RP_r & P_l \times RP_r \end{bmatrix}$

d) using cofficient (a, b, c) of the traingulated point

$$P = a P_l T \frac{1}{2} GW$$

$$P = \frac{1}{2}[a P_l + b R P_r + T]$$

f) Matrix can be normalized to have a baseline of 1 by →

$$E = \frac{2}{tr(E^T E)} \cdot E$$

Since we do not know R and T, the normalized matrix is to be expressed in linear of cofficient of E only

g) To determine the unknown sign of rotation and translation for euclidean reconstruction, we use all four combinations, (+ +), (− −), (+ −) and (− +) to reconstruct the point and only use the combination for which all three co-ord are positive for point P.