Introduction to Computer Vision

Problem Set 5 Report

Computer Engineering

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Problem 1:

I read my two input image from input file and to find features easily, I converted them to gray scale.

Input 1

Input 2

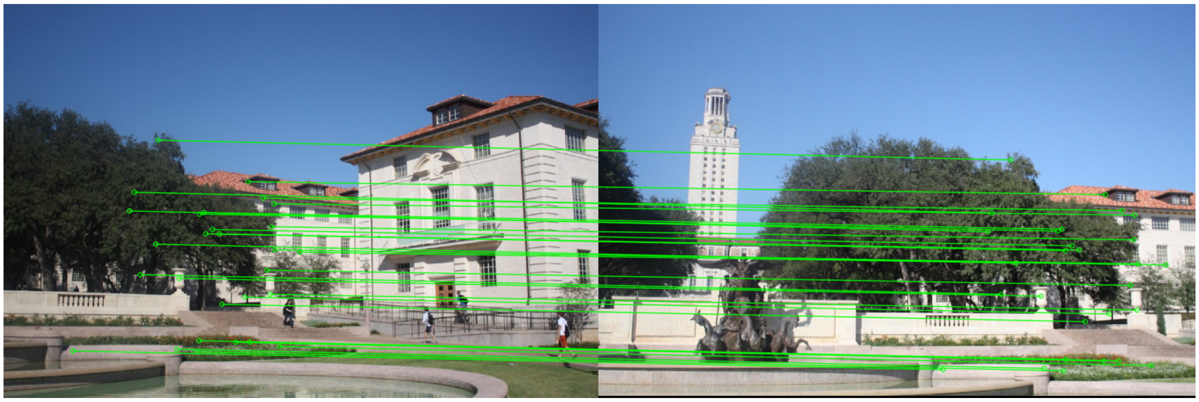
Then to calculate the feature of the images, which are key points and descriptors I selected SIFT method

Input 1 Sift Keypoints

Input 2 Sift Keypoints

Brute-Force Matcher takes the descriptor of one feature in first set and is matched with all other features in second set using some distance calculation. And the closest one is returned.

I took the good matches with thresh hold number = 0.25



Best Sift Matches

Using Ransac method i found homography matrix and then I found common areas between my two input images.

Common areas

I warped two images

Warped Image

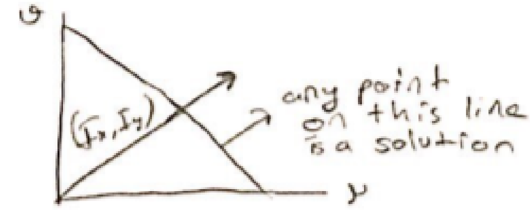
Lastly I trimmed the picture

After Trim Stitched Image

Problem 2:

Problem 2

a) When we were doing corner finding, we can only tell how much is being moved perpendicular to the edge. Some thing is happening here. Locally we can only tell the amount of motion that is perpendicular to the edge in a little area.



b) If we use a 5x5 window that gives us 25 equation per pixel

$$\underbrace{\begin{bmatrix} I_x(p_1) & I_y(p_1) \\ I_x(p_2) & I_y(p_2) \\ \vdots & \vdots \\ I_x(p_{25}) & I_y(p_{25}) \end{bmatrix}}_{\substack{\text{Matrix } A \\ 25\times 2}} \underbrace{\begin{bmatrix} u \\ v \end{bmatrix}}_{\substack{\text{vector } d \\ 2\times 1}} = - \underbrace{\begin{bmatrix} I_t(p_1) \\ I_t(p_2) \\ \vdots \\ I_t(p_{25}) \end{bmatrix}}_{\substack{\text{vector } b \\ 25\times 1}}$$

I_x and I_y are computed $\rightarrow \frac{1}{8}\underbrace{\begin{bmatrix} -1 & 0 & 1 \\ -2 & 0 & 2 \\ -1 & 0 & 1 \end{bmatrix}}_{S_x}, \frac{1}{8}\underbrace{\begin{bmatrix} 1 & 2 & 1 \\ 0 & 0 & 0 \\ -1 & -2 & -1 \end{bmatrix}}_{S_y}$

$$I_t(p) = I^{t+1}(p) - I^{t}(p)$$

Then $Ad = b \longrightarrow$ minimize $\|Ad - b\|^2$

$$\underset{2\times 2}{(A^T A)}\ \underset{2\times 1}{d} = \underset{2\times 1}{A^T b} \rightarrow \begin{bmatrix} \Sigma I_x I_x & \Sigma I_x I_y \\ \Sigma I_x I_y & \Sigma I_y I_y \end{bmatrix} \begin{bmatrix} u \\ v \end{bmatrix} = - \begin{bmatrix} \Sigma I_x I_t \\ \Sigma I_y I_t \end{bmatrix}$$

c) Yes, $\left(I_x(x,y), I_y(x,y)\right) \alpha \neq \left(I_x(x+1,y+1), I_y(x+1,y+1)\right)$

If this equation is not true then we have not have 2 distinct equation we have 1 equation.

e)

$I_x(2,2) = 10-9=1,\ I_y(2,2) = 10-9=1,\ I_t(2,2) = 7-9 = -2$

$$\begin{bmatrix} 1 & 1 \end{bmatrix} \begin{bmatrix} u \\ v \end{bmatrix} = -\begin{bmatrix} -2 \end{bmatrix} \rightarrow u + v = 2$$

$I_x(3,3) = 12-10 = 2,\ I_y(3,3) = 13-10 = 3\quad I_t(3,3) = 9-10 = -1$

$$\begin{bmatrix} 2 & 3 \end{bmatrix} \begin{bmatrix} u \\ v \end{bmatrix} = -\begin{bmatrix} -1 \end{bmatrix} \rightarrow 2u + 3v = 1$$

$$\begin{matrix} u+v=2 \\ 2u+3v=1 \end{matrix} \longrightarrow \boxed{v=5\quad u=-3}$$

Problem 3:

Problem 3

a) $X_3, Y_3, Z_3 = (X_1+X_2,\ Y_1+Y_2,\ Z_1+Z_2)$

$$(x_3, y_3) = \left(\frac{X_1+X_2}{X_3+Y_3+Z_3},\ \frac{Y_1+Y_2}{X_3+Y_3+Z_3}\right) \text{ from } x = \frac{X}{X+Y+Z},\ y = \frac{Y}{X+Y+Z}$$

$$= \left(\frac{X_1}{X_3+Y_3+Z_3},\ \frac{Y_1}{X_3+Y_3+Z_3}\right) + \left(\frac{X_2}{X_3+Y_3+Z_3}\ \frac{Y_2}{X_3+Y_3+Z_3}\right)$$

$$= \underbrace{\frac{X_1+Y_1+Z_1}{X_3+Y_3+Z_3}}_{k} \underbrace{\left(\frac{X_1}{X_1+Y_1+Z_1},\ \frac{Y_1}{X_1+Y_1+Z_1}\right)}_{(x_1,\, y_1)} + \underbrace{\frac{X_2+Y_2+Z_2}{X_3+Y_3+Z_3}}_{k'} \underbrace{\left(\frac{X_2}{X_2+Y_2+Z_2},\ \frac{Y_2}{X_2+Y_2+Z_2}\right)}_{(x_2,\, y_2)}$$

$$k = \frac{x_1 + y_1 + z_1}{x_3 + y_3 + z_3} = \frac{x_1 + y_1 + z_1}{(x_1 + y_1 + z_1) + (x_2 + y_2 + z_2)}$$

$$k' = \frac{x_2 + y_2 + z_2}{x_3 + y_3 + z_3} = \frac{x_2 + y_2 + z_2}{(x_1 + y_1 + z_1) + (x_2 + y_2 + z_2)}$$

$$k + k' = \frac{(x_1 + y_1 + z_1) + (x_2 + y_2 + z_2)}{(x_1 + y_1 + z_1) + (x_2 + y_2 + z_2)} = 1 \qquad k' = (1 - k)$$

$$(x_3, y_3) = k(x_1, y_1) + (1-k)(x_2, y_2)$$

$$\boxed{x_3 = k x_1 + (1-k) x_2} \qquad \boxed{y_3 = k y_1 + (1-k) y_2}$$

b) when $x_1 + y_1 + z_1 = x_2 + y_2 + z_2$

$$k = \frac{x_1 + y_1 + z_1}{(x_1 + y_1 + z_1) + (x_2 + y_2 + z_2)} = \frac{\cancel{x_1 + y_1 + z_1}}{2\,(\cancel{x_1 + y_1 + z_1})} = \boxed{0.5}$$