Computer Vision
Assignment 4

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Spring 2022

1 Robust Homography Estimation and Stitching

Exercise 1

We have two cameras $P_1 = [A_1 \;\; t_1]$ and $P_2 = [A_2 \;\; t_2]$ with the same camera center. To show that there exists a homography H between the two, we start with the expression for the camera center.

$$\begin{cases} P_1 \begin{bmatrix} C_1 \\ 1 \end{bmatrix} = A_1 C_1 + t_1 \iff C_1 = -A_1^{-1} t_1 \\ P_2 \begin{bmatrix} C_2 \\ 1 \end{bmatrix} = A_2 C_2 + t_2 \iff C_2 = -A_2^{-1} t_2 \end{cases}.$$

Since the camera centers are the same the relation between t_1 and t_2 are

$$\begin{aligned} C_1 = C_2 \iff \quad -A_1^{-1} t_1 &= -A_2^{-1} t_2 \\ A_2 A_1^{-1} t_1 &= A_2 A_2^{-1} t_2 \\ A_2 A_1^{-1} t_1 &= t_2. \end{aligned}$$

If the 3D points $\mathbf{X}_i = \begin{bmatrix} X_i \\ 1 \end{bmatrix}$ are projected with the two cameras respectively

$$\begin{cases} \gamma_i \mathrm{x}_i &= P_1 \begin{bmatrix} X_i \\ 1 \end{bmatrix} = A_1 X_i + t_1 \\ \eta_i \mathrm{y}_i &= P_2 \begin{bmatrix} X_i \\ 1 \end{bmatrix} = A_2 X_i + t_2 \end{cases}$$

which gives

$$\begin{aligned} \eta_i \mathrm{y}_i &= A_2 A_1^{-1} \gamma_i \mathrm{x} - A_2 A_1^{-1} t_1 + t_2 \\ \eta_i \mathrm{y}_i &= A_2 A_1^{-1} \gamma_i \mathrm{x} - t_2 + t_2 \\ \eta_i \mathrm{y}_i &= A_2 A_1^{-1} \gamma_i \mathrm{x} \end{aligned}$$

From the last equation we can see that $P_2\mathbf{X}_i = A_2A_1^{-1}P_1\mathbf{X}_i$, which means that the homography that transforms the first image the second is $H = A_2A_1^{-1}$.

Exercise 2

- Degrees of freedoms: 8
- Minimal number of correspondence: 4
- Number of RANSAC iterations: 4

Computer Exercise 1

2 Robust Essential Matrix Estimation

- Degrees of freedoms: 5
- Minimal number of correspondence: 5
- Number of RANSAC iterations: 5

Computer Exercise 1

How many SIFT features did you find for the two images, respectively? How many matches did you find?

- SIFT features in image a = 947
- SIFT features in image b = 865
- Number of matches = 204
- Number of inliers = 126

Computer Exercise 2

Number of inliers = 1465 and RMS = 0.6039.

3 Calibrated Structure from Motion and Local Optimization

Computer Exercise 3

RMS = 0.3314.

Computer Exercise 4

RMS = 0.2401.

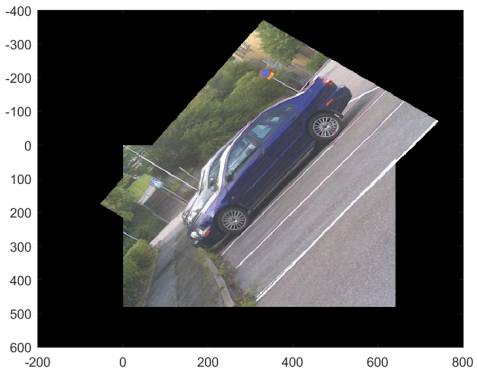

Figure 1: Reconstruction for computer exercise 2

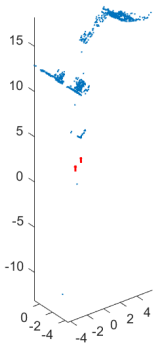

Figure 2: Reconstruction for computer exercise 2

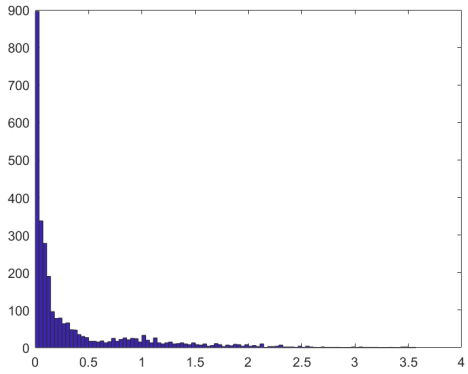

Figure 3: Histogram for computer exercise 2

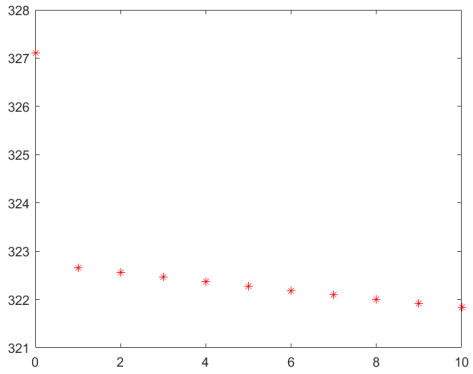

Figure 4: Resulting plot for computer exercise 3

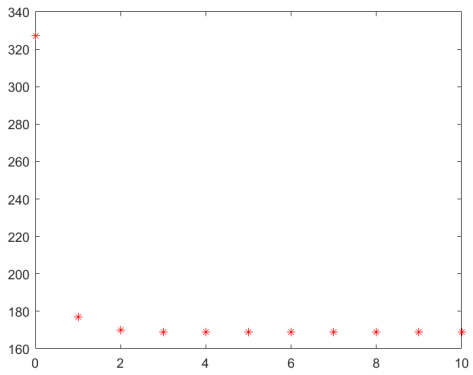

Figure 5: Resulting plot for computer exercise 4