Lund University

Center for Mathematical Sciences

FMAN95

Computer Vision

Assignment 4

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Submitted: March 22, 2024

2 Robust Homography Estimation and Stitching

Exercise 1

Since P_1 and P_2 have the same camera center we have

$$C = -A_1^{-1}t_1 = -A_2^{-1}t_2.$$

Camera equations can be written

$$\lambda_1 x_1 = A_1 X + t_1 \Leftrightarrow X = -A_1^{-1}t_1 + \lambda_1 A_1^{-1}x_1.$$

$$\lambda_2 x_2 = A_2 X + t_2 \Leftrightarrow X = -A_2^{-1}t_2 + \lambda_2 A_2^{-1}x_2.$$

We get

$$-A_1^{-1}t_1 + \lambda_1 A_1^{-1}x_1 = -A_2^{-1}t_2 + \lambda_2 A_2^{-1}x_2.$$

$$C + \lambda_1 A_1^{-1}x_1 = C + \lambda_2 A_2^{-1}x_2 \Leftrightarrow \lambda_1 A_1^{-1}x_1 = \lambda_2 A_2^{-1}x_2$$

Finally we get

$$\frac{\lambda_1}{\lambda_2}x_1 = \lambda x_1 = A_1 A_2^{-1}x_2 = Hx_2.$$

Exercise 2

The Homography has $8 + n$ degrees of freedom. To be able to find H we need

$$3n \geq 8 + n \Leftrightarrow 2n \geq 8 \Leftrightarrow n \geq 4$$

point correspondences.
The probability of selecting an inlier set is 0.9^4. Therefore the probability of failing to do so is $1 - 0.9^4$. Now suppose we sample consensus sets n times. Finding an inlier set at least ones is the complement event of failing to find an inlier set all n times. The probablility of failing n times is $(1 - 0.9^4)^n$. We should therefore have

$$(1 - 0.9^4)^n < 1 - 0.98 \Rightarrow n \log(1 - 0.9^4) \leq \log(1 - 0.98) \Rightarrow n \geq \frac{\log(1 - 0.98)}{\log(1 - 0.9^4)} \approx 3.66.$$

Therefore $n = 4$ works.

Computer Exercise 1

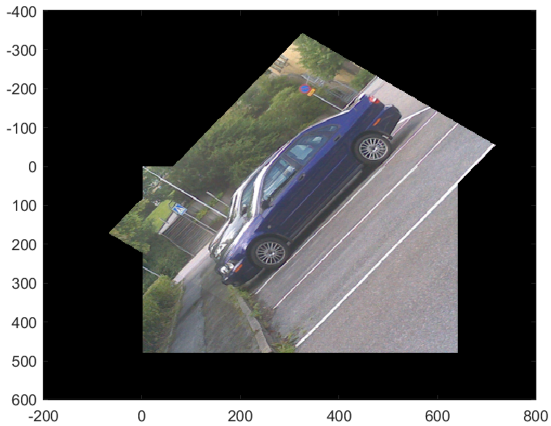


Figure 1: Panorama plot.

3 Robust Essential Matrix Estimation

Exercise 3

Since the scale of the essential matrix does not matter it has 5 degrees of freedom.
The minimal number of point correspondences that we need to determine the essential matrix is 5.
The probability of selecting an inlier set is 0.9^8. Therefore the probability of failing to do so is $1 - 0.9^5$. Now suppose we sample consensus sets n times. Finding an inlier set at least ones is the complement event of failing to find an inlier set all n times. The probablility of failing n times is $(1 - 0.9^5)^n$. We should therefore have

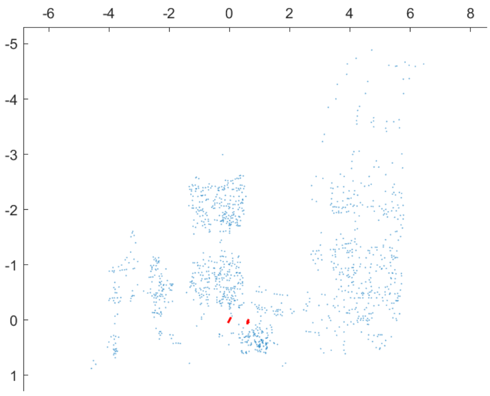
$$(1 - 0.9^5)^n < 1 - 0.98 \Rightarrow n\log(1 - 0.9^5) \leq \log(1 - 0.98) \Rightarrow n \geq \frac{\log(1 - 0.98)}{\log(1 - 0.9^5)} \approx 4.38.$$

Therefore $n = 5$ works.

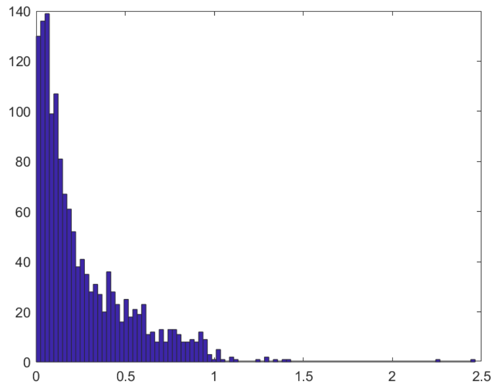
Computer Exercise 2

The number of inliers: 1465.
RMS Error: 0.26365.

Figure 2: Reprojection points.



(a) Reconstruction.



(b) Error histogram.

Figure 3: Plots for Computer Exercise 2.

4 Calibrated Structure from Motion and Local Optimization

Computer Exercise 3

Final RMS value: 102.069230.

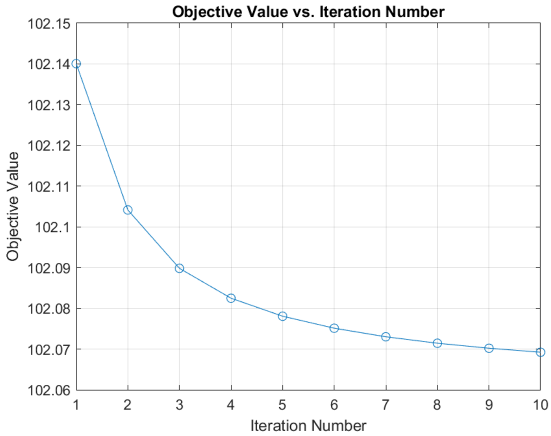


Figure 4: Objective values.

Computer Exercise 4

Final RMS value: 59.935285.

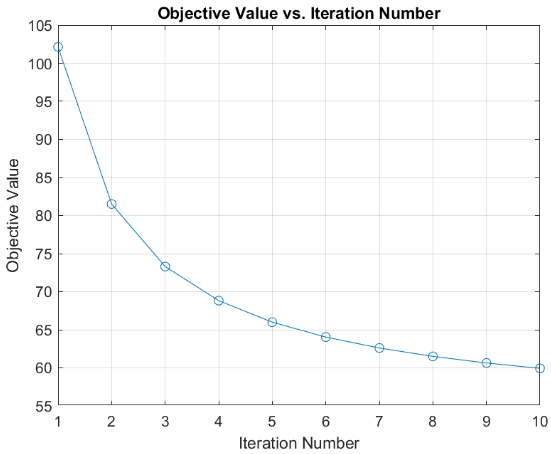


Figure 5: Objective values.