Assignment 4 FMAN95

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1 Exercises

Exercise 1.

If $P_2X = 0$ and $P_1X = 0$ then they have the same camera centers. Therefore $P_2 = Q P_1$ where Q is any constant.

From 5.3: $C_i = -A_i^{-1} t_i$ is the camera center.

So, $C = -A_1^{-1} t_1 = -A_2^{-1} t_2$ and $PC = 0$ must be true.

Also they need to be in the same point in space so $t_1 = t_2$

Can also divide to intrinsic & extrinsic parameters:

Because $C_1 = C_2$ & $t_1 = t_2 \longrightarrow P = [A \; t]$

$x_2 = [A_2 \; t]X = A_2 A_1^{-1} x_1 \longrightarrow H = A_2 A^{-1}$

Because we can write X as $X = inv(A_1) x_1 \longrightarrow x_2 = (A_2 \; t) \, inv(A_1)$

Exercise 2.

$$H = \begin{bmatrix} h_{11} & h_{12} & h_{13} \\ h_{21} & h_{22} & h_{23} \\ h_{31} & h_{32} & h_{33} \end{bmatrix}$$ has 8 degrees of freedom as it's generalized with $h_{33} = 1$

Need 4 point correspondences as each gives two equations. → Solves for 8 unknowns. (4 random points)

10% is wrong. → Probability of selecting inlier = $0{,}9^4$

$$n \geq \frac{\log(1-0{,}98)}{\log(1-0{,}9^4)} \approx 3{,}66$$ so 4 iterations will be enough

Exercise 3:

Essential matrix has 5 degrees of freedom.

Need at least 8 point correspondences.

$$n \geq \frac{\log(1-0{,}98)}{\log(1-0{,}9^8)} \approx 6{,}9$$ so 7 iterations work.

2 Robust Homography Estimation and Stitching

Computer Exercise 1
Using the OpenCV SIFT feature I found 535 matches in total between the two images, see figure 1. With 100 iterations of the RANSAC algorithm the best solution got 279 inliers with the H matrix: $\begin{bmatrix} 0.6 & 0.8 & -67.4 \\ -0.8 & 0.6 & 167.5 \\ -7.1 & -1.1 & 1 \end{bmatrix}$

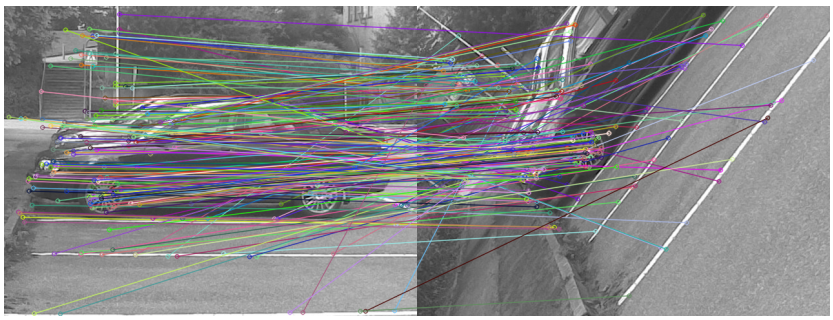

Figure 1: SIFT from the two images. Shows the 200 best matches.

3 Robust Essential Matrix Estimation

Computer Exercise 2
The maximum number of inliers I got was 846 with 100 iterations. The P2 camera matrix that I got from the essential matrix that had the most number of points in front of the camera was P2 = $\begin{bmatrix} -0.21 & 0.80 & 0.57 & -0.26 \\ -0.76 & 0.24 & -0.61 & 0.09 \\ 0.62 & 0.56 & -0.55 & 0.96 \end{bmatrix}$

4 Calibrated Structure from Motion and Local Optimization

Computer Exercise 3 and 4
I started a Python attempt which can be found in the zip but unfortunately I can't seem to get the help functions LinearizeReprojErr to work properly. I am working on a solution in Matlab.