Assignment 4

Shuai

March 12, 2023

# 1 Robust Homography Estimation and Stitching

E1:

Text, letter

Description automatically generated

Figure 1

E2:

Degrees of freedom is 8.

Minimal number of point correspondences is 4.

Iterations of RANSAC is

CE1:

The number of SIFT features in a is 947.

The number of SIFT features in b is 865.

The number of matches is 204.

The number of inliers is 149.

Graphical user interface, application

Description automatically generated

Figure 2

**2 Robust Essential Matrix Estimation**

E3:

Degrees of freedom is 5.

Minimal number of point correspondences is 5.

Iterations of RANSAC is

CE2:

The number of inliers = 1465



Graphical user interface, application

Description automatically generated

Figure 3

Graphical user interface

Description automatically generated

Figure 4

# 3 Calibrated Structure from Motion and Local Optimization

CE3:

The final RMS error is 0.3939.

Chart, scatter chart

Description automatically generated

Figure 5

CE4:

The final RMS error is 0.2461.

A picture containing graphical user interface

Description automatically generated

Figure 6

# 4 Dynamic Objects and Factorization

E4:

The matrix X can be rewritten as X = CkB + t, where C = [c1 c2 ... cm] is a matrix with the vectors cik as columns, B = [B1 B2 ... Bn] is a matrix with the vectors Bj as rows, and t1 is a vector of all ones. Since the row vectors B1,...,Bn and 1 are linearly independent, the rank of X is n+1.

To minimize ∥A − X∥2F, we can set the gradient of the objective function with respect to X to zero:

∇X(∥A − X∥2F) = -2(A - X) = 0

This yields X = A. Substituting X in the equation for X, we get:

A = CKB + t

Multiplying both sides by 1t1, we get:

tA = tCKB + tt

Since tB = [sum(B1) sum(B2) ... sum(Bn)] = nB ̄, where B ̄ is the mean row vector of B, and (1t1)t1 = n, we have:

tA = nCKB ̄ + n

Dividing both sides by n, we get:

A ̄ = CKB ̄ + 1,

where A ̄ is the row mean vector of A. Solving for ti, we get:

ti = A ̄i − cikB ̄k,

where A ̄i is the row mean vector of [ai1 ai2 . . . ain] and B ̄k is the mean row vector of Bk.

To find Bk and cik when ti has been eliminated:

Compute the mean row vector B ̄ of B.

Subtract B ̄ from each row vector Bj to get the centered row vectors Bj ̃ = Bj - B ̄.

Compute the centered matrix C ̃ = [c1 ̃ c2 ̃ ... cm ̃], where cik ̃ = cik - tiB ̄k.

Solve for the centered matrix C ̃ by minimizing the objective function ∥A ̃ - ∥C ̃B ̃∥2F, where A ̃ is the centered matrix of A, and B ̃ = [B1 ̃ B2 ̃ ... Bn ̃] is the matrix with the centered row vectors Bj ̃ as rows.

Once C ̃ and B ̃ have been found, we can compute Bk as Bk = B ̃k + B ̄, and cik as cik = cik ̃ + ti.

Note that this method assumes that the noise in the measurements aij is uncorrelated and has zero mean.