Exercise1 Solution

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PartA - 1

Attached at the end of the exercise

PartA - 3

Homography with perfect matches:
[[-1.12313781e-03 -1.64757662e-04 9.99919585e-01]
 [-1.05117244e-05 -1.05462483e-03 1.25622164e-02]
 [-2.96940746e-07 -4.35706348e-08 -7.82907867e-04]]

PartA2 - 6

The problem with forward mapping is that there are some pixels in the dest image that do not have a source pixel mapped to them. So there are some black pixels in the forward mapping.

PartA2 - 7

We got a different result compared to section 6 because there are outlier matching points in the matches.mat file. So the calculated homography is not correct.

PartB - 10

The number of iterations to achieve an accuracy p is
$k = ln(1 - p)/ln(1 - w^n)$ where n is the number of points sufficient to compute the model (which is 4 for homography)
w=0.8, n=4
For p=90%, k=5
For p=99%, k=9
To cover all the cases $30\ choose\ 4$ iterations is needed which is 27405

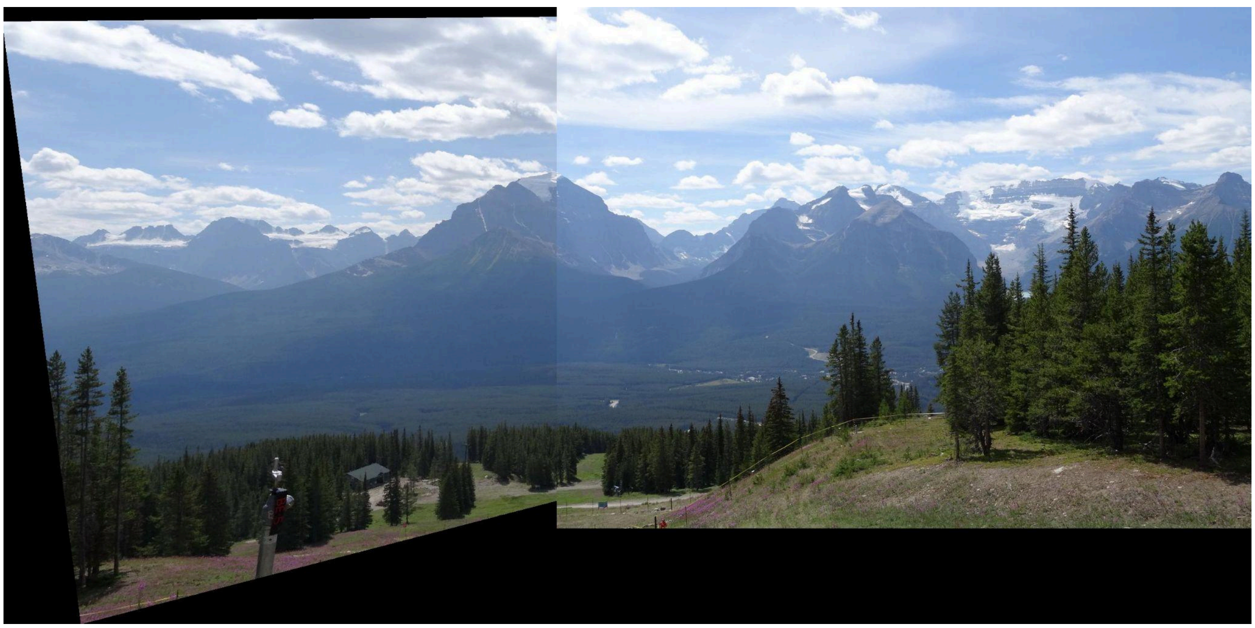
PartB - 12

The calculated ransac homography:
[[1.12313781e-03 1.64757662e-04 -9.99919585e-01]
 [1.05117245e-05 1.05462483e-03 -1.25622165e-02]
 [2.96940746e-07 4.35706350e-08 7.82907867e-04]]

Is identical to the homography calculated using perfect matches in section5.
The homography accuracy is 80%, it makes sense because 80% is the inliers precent

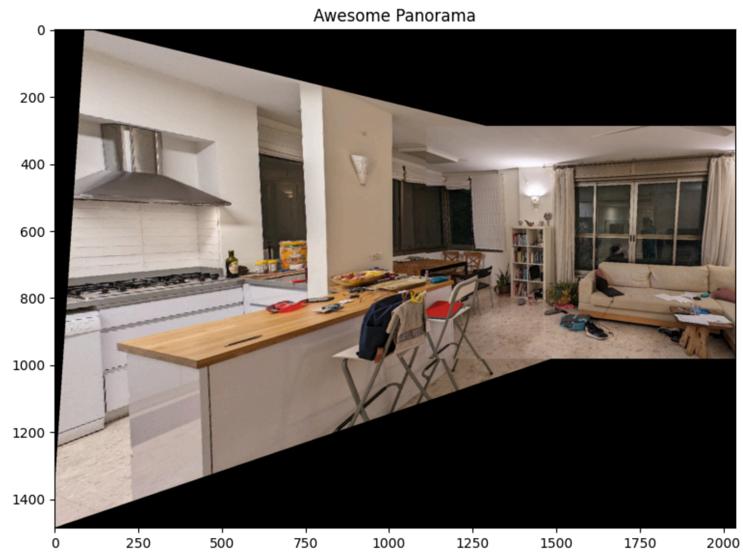
Part C

My beautiful panorama:



My images

Panorama



Part1A

PART A

1

$\underline{A}\underline{x} = \underline{b}$

A - Homography

$$\begin{pmatrix} a_{11} & a_{12} & a_{13} \\ a_{21} & a_{22} & a_{23} \\ a_{31} & a_{32} & a_{33} \end{pmatrix} \begin{pmatrix} x \\ y \\ 1 \end{pmatrix} = \begin{pmatrix} b_1 \\ b_2 \\ 1 \end{pmatrix}$$

due to homogenus coordinates

$$b_1 = \frac{a_{11}x + a_{12}y + a_{13}}{a_{31}x + a_{32}y + a_{33}} \qquad \Big/ \cdot \; a_{31}x + a_{32}y + a_{33}$$

$$b_2 = \frac{a_{21}x + a_{22}y + a_{23}}{a_{31}x + a_{32}y + a_{33}}$$

$$b_1 \cdot (a_{31}x + a_{32}y + a_{33}) = a_{11}x + a_{12}y + a_{13}$$

$$b_2 (\quad " \quad " \quad " \quad) = a_{21}x + a_{22}y + a_{23}$$

Lets put it in matrix form.

$$0 = \begin{pmatrix} x & y & 1 & 0 & 0 & 0 & -b_1 x & -b_1 y & -b_1 \\ 0 & 0 & 0 & x & y & 1 & -b_2 x & -b_2 y & -b_2 \end{pmatrix} \begin{pmatrix} a_{11} \\ a_{12} \\ a_{13} \\ a_{21} \\ a_{22} \\ a_{23} \\ a_{31} \\ a_{32} \\ a_{33} \end{pmatrix}$$

each matching point generates 2 equations.

we will have $2 \cdot M$ equations where M is the matching point number
we can rewrite the systems like

$$\underline{M}\, a = 0$$

where $\underline{a}$ is the vector $\begin{pmatrix} a_{11} \\ \vdots \\ a_{33} \end{pmatrix}$ and M is the system of equations

we dont want a to be the trivial solution
so we set $\boxed{\|a\|^2=1}$ and we can do that
because we know a up to a factor

~~because~~ and we want $Ma=0$ so we can
define the following func to minimize.
min $\|Ma\|^2$ $\|a\|^2$ and the minimum will be

as close to $Ma=0$ as we can get

so we can define a loss function:

$$L = |Ma|^2 - \lambda(|a|^2-1)$$

$$= a^T M^T Ma - \lambda(a^t a - 1)$$

$\rightarrow$ derivate and compare to 0 $\quad 2M^TMa - 2\lambda a = 0 \rightarrow \boxed{M^TMa = \lambda a}$

So we need to find the smallest
eigen value of M^TM and the eigen
vector a.