RBE549 - Homework 6

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Due date: October 16, 2022

Problem 1

In this problem we aim to take a series of overlapping photographs and try to recombine them.

A

We start with the following image and divide it into three overlapping parts:

Figure 1: Full Image of La Jolla Cove

We break this down into four sections:

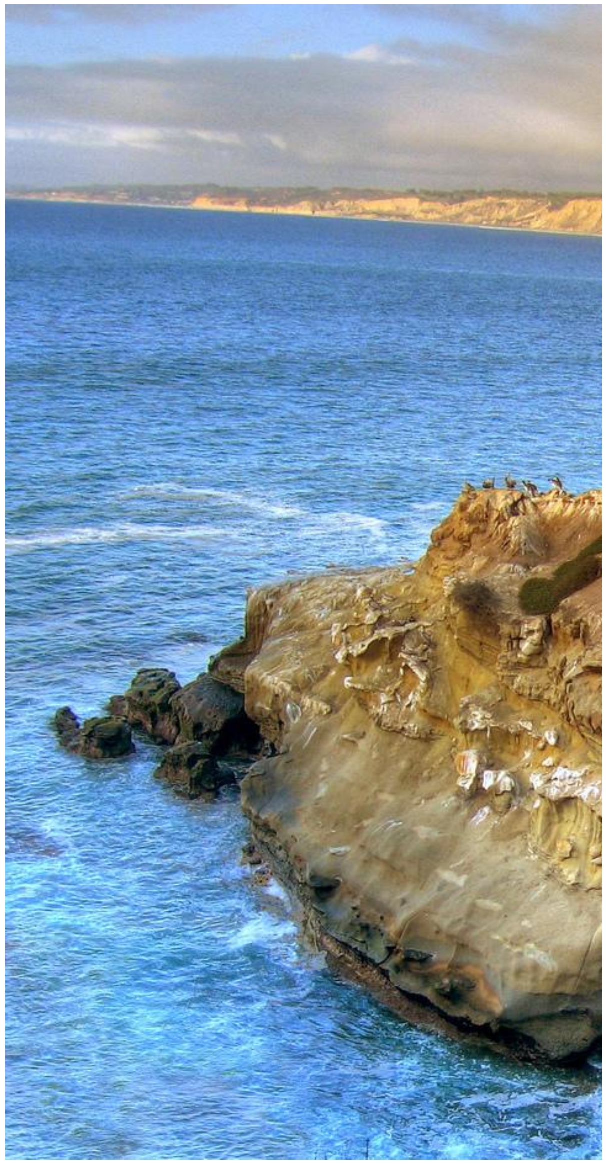

Figure 2: Left side of the cove

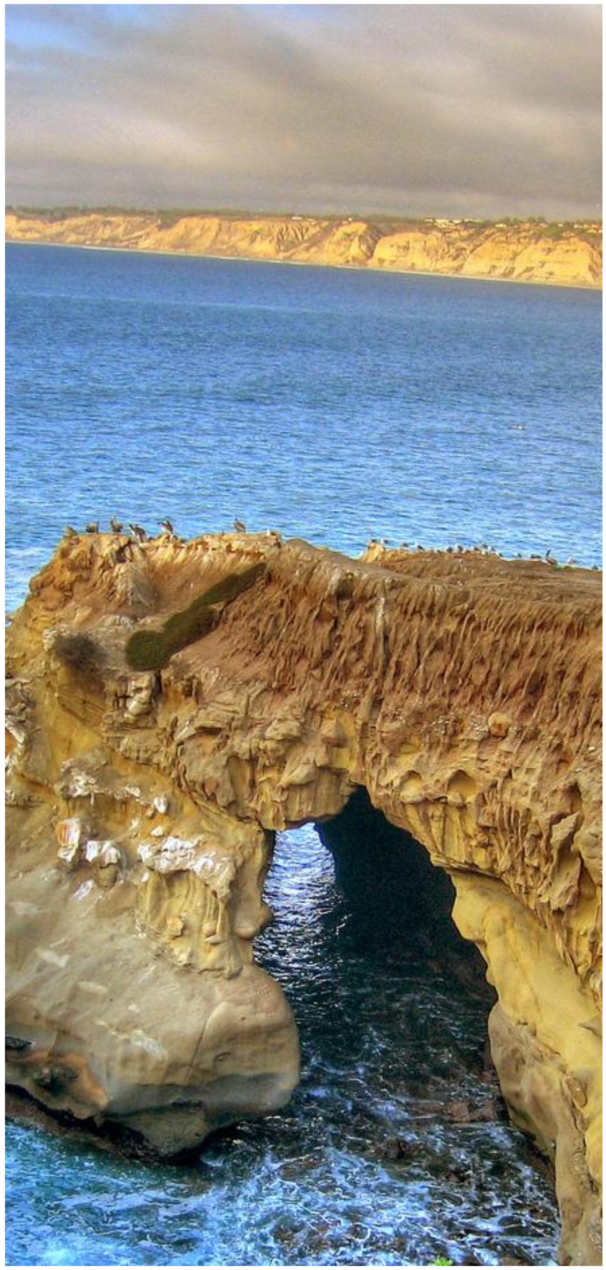

Figure 3: Middle of the cove

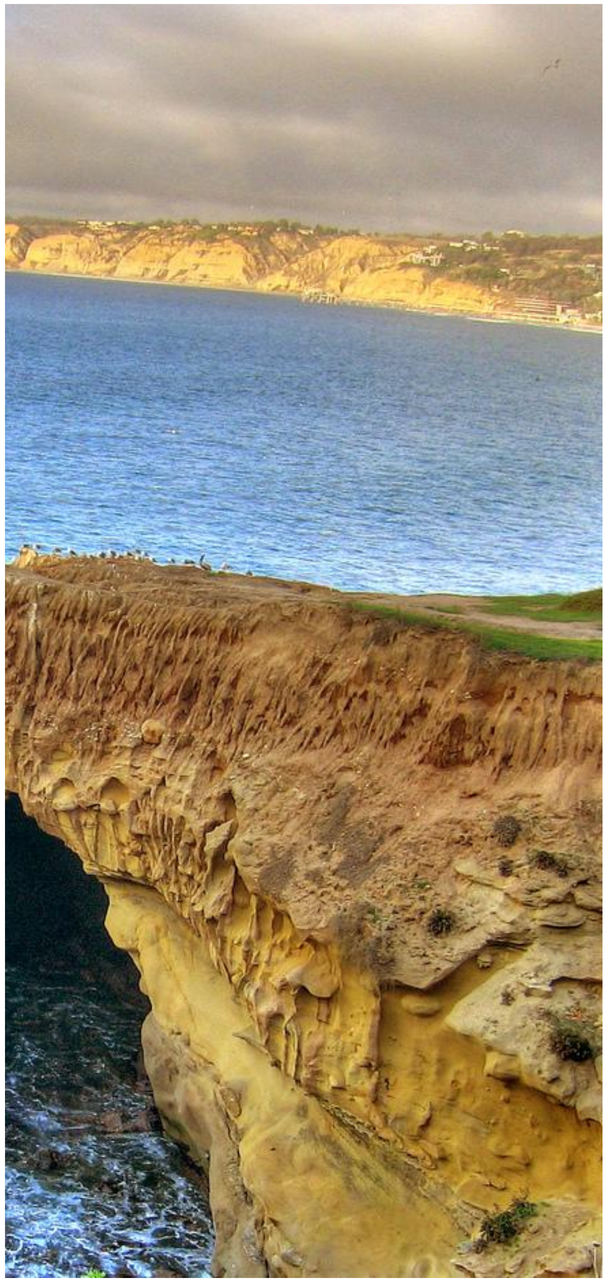

Figure 4: Right side of the cove

B

Here we identify a series of features across the different sections, and try to match features across the features:

Figure 5: Left/Middle

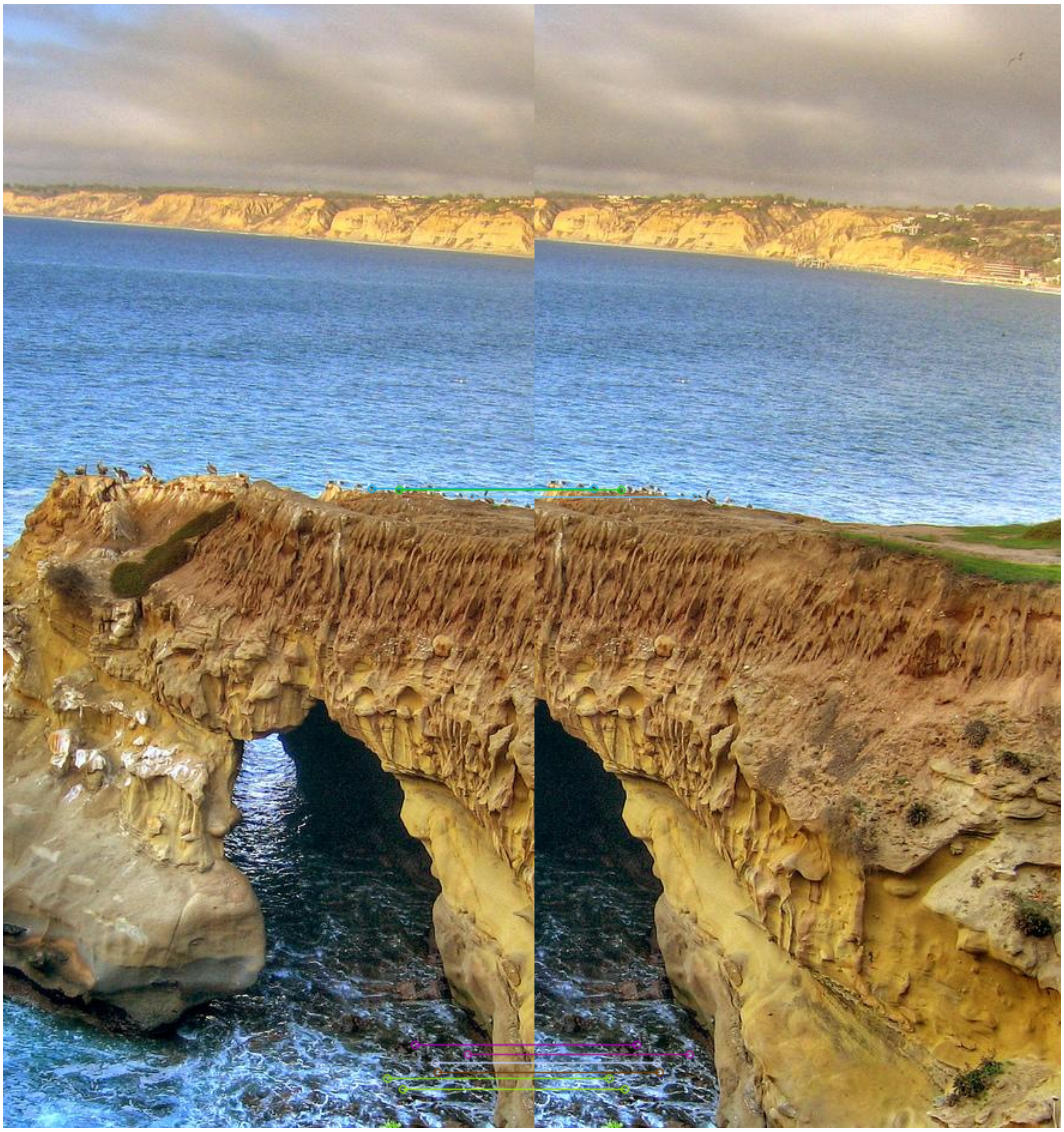

Figure 6: Middle/Right

C

Here we are asked to provide a global translation for each image. First, we grab the match results of our pairs - left/middle and middle/right. We assumed here that the left side is situated correctly, which for our side means a translation of [**0**].

In our code within *problem1.py*, we iterate through the existing points and calcultae the average global translation for each pair. To this end, our software spits out two global translations. For left/middle it resulted in a translation of $(x, y) = (-326, 0)$ and for right/middle $(x, y) = (-258, 0)$. This makes sense, as how I cut the image was straight cutting the image into sections, suggesting a straight x oriented translation would be all that's required.

D

To get to the final matching, we will pair the left and middle sides, then feature check the resulting image against the right image.

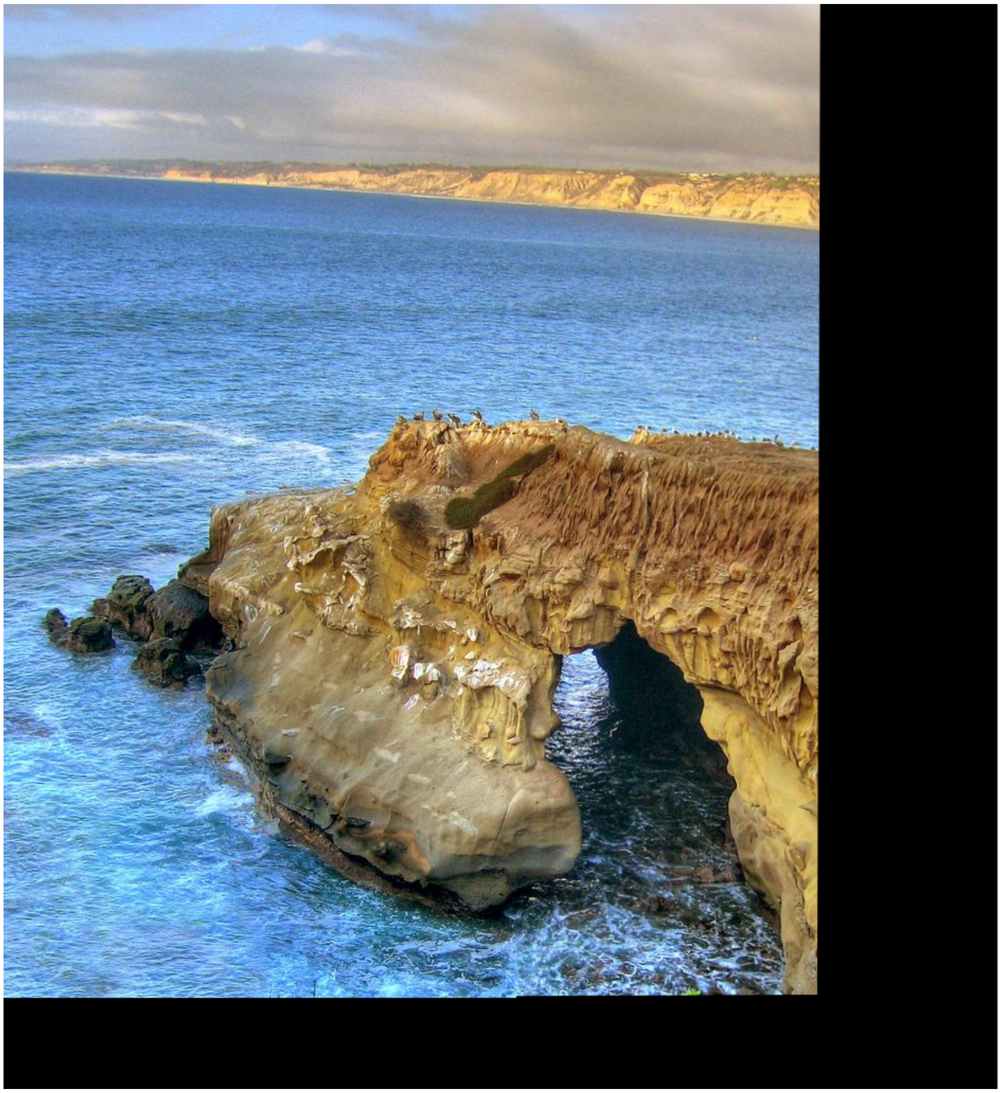

Figure 7: Left/Middle pairing

Then we compare this result against the right side:

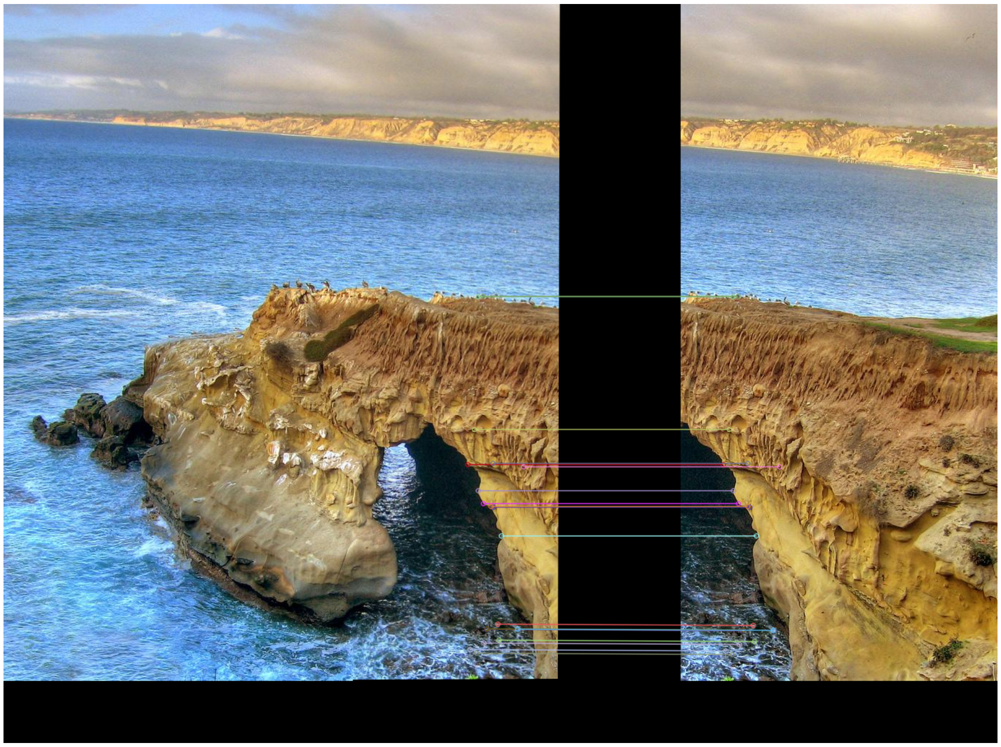

Figure 8: Left/Middle - Right Matches

This leads us to the final output of:

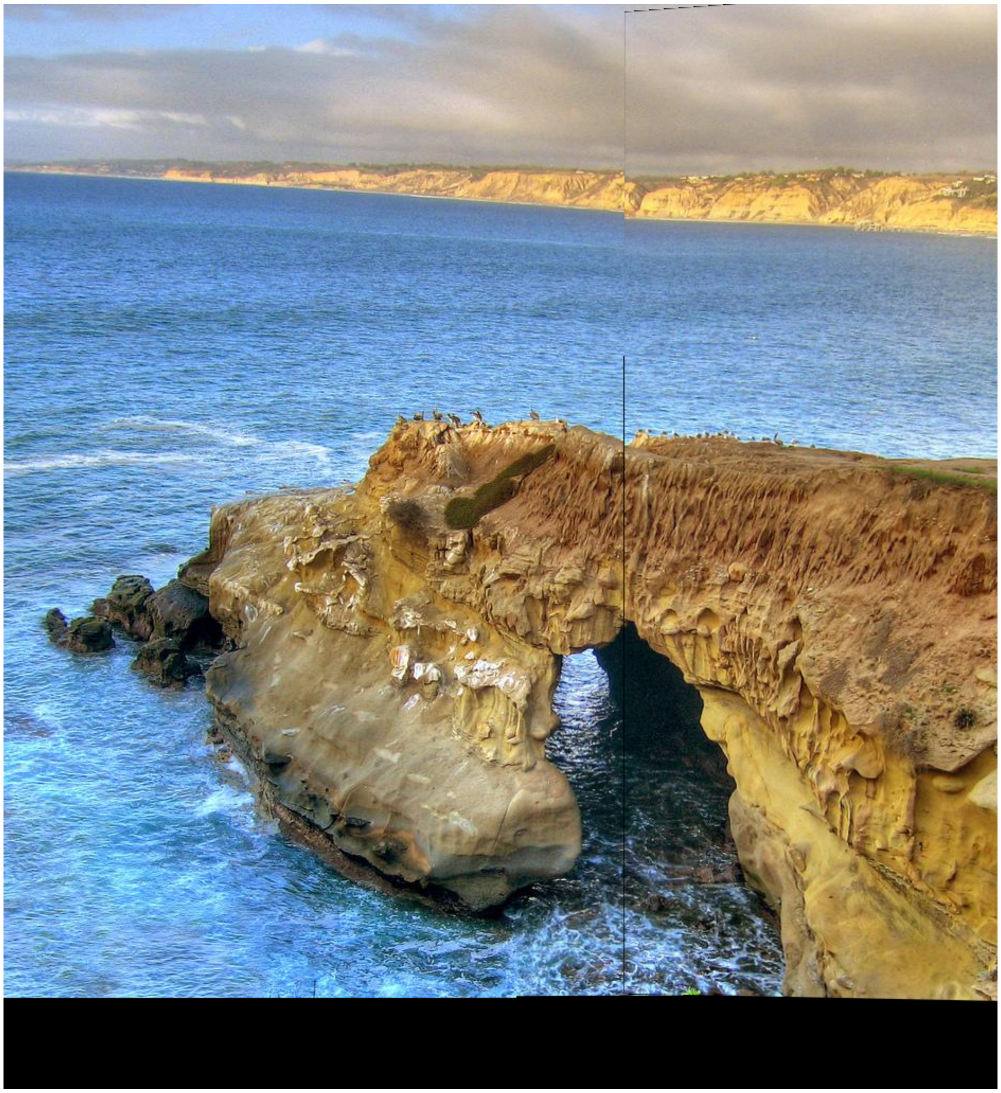

Figure 9: Fully Combined

Problem 2

Here we are presented with two images, seen below:

Figure 10: Image 1

Figure 11: Image 2

A

First we pick equivalent spots, tracking them, across the images to try and create a perspective morph. First, our points:

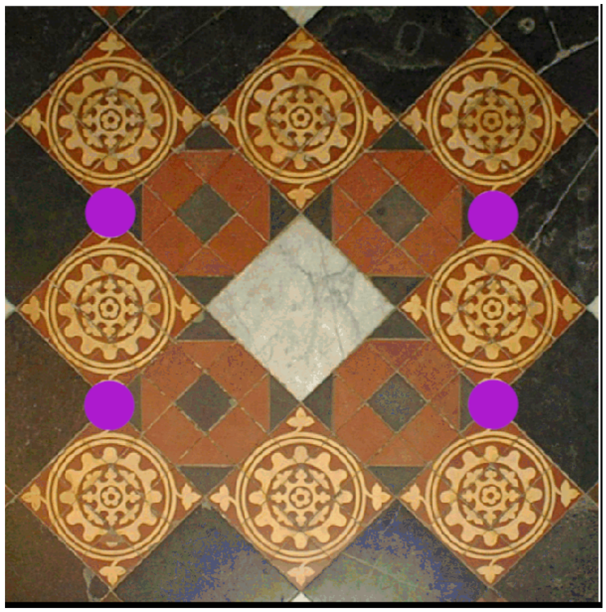

Figure 12: Image 1

Figure 13: Image 2

Our points, as follows:

Point	x_s	y_s	x_d	x_d
1	105	210	140	135
2	105	404	107	246
3	490	210	460	130
4	420	210	496	246

(1)

B

We now hope to calculate the homography matrix. To do this we must solve the following:

$$\begin{bmatrix} x^s \\ y^s \\ 1 \end{bmatrix} = \begin{bmatrix} 1+h_{11} & h_{12}+h_{13} & \\ h_{21} & 1+h_{22} & h_{23} \\ h_{31} & h_{32} & 1 \end{bmatrix} = \begin{bmatrix} x^d \\ y^d \\ 1 \end{bmatrix} \tag{2}$$

To solve for h, we can solve it using the following equation:

$$A = \begin{bmatrix} x_s^1 & y_s^1 & 1 & 0 & 0 & 0 & -x_d^1 x_s^1 & -x_d^1 y_s^1 & -x_d^1 \\ 0 & 0 & 0 & x_s^1 & y_s^1 & 1 & -y_d^1 x_s^1 & -y_d^1 y_s^1 & -y_d^1 \\ \vdots & \vdots & \vdots & \vdots & \vdots & \vdots & \vdots & \vdots & \vdots \\ x_s^4 & y_s^4 & 1 & 0 & 0 & 0 & -x_d^4 x_s^4 & -x_d^4 y_s^4 & -x_d^4 \\ 0 & 0 & 0 & x_s^4 & y_s^4 & 1 & -y_d^4 x_s^4 & -y_d^4 y_s^4 & -y_d^4 \end{bmatrix} \tag{3}$$

$$h = \begin{bmatrix} h_{11} \\ h_{12} \\ h_{13} \\ h_{21} \\ h_{22} \\ h_{23} \\ h_{31} \\ h_{32} \\ h_{33} \end{bmatrix} \tag{4}$$

And with these we can then solve it by setting it equal to :

$$Ah = \begin{bmatrix} 0 \\ 0 \\ 0 \\ 0 \\ 0 \\ 0 \\ 0 \\ 1 \end{bmatrix} \tag{5}$$

...from this we can solve that h is equal to:

$$h = \begin{bmatrix} h_{11} \\ h_{12} \\ h_{13} \\ h_{21} \\ h_{22} \\ h_{23} \\ h_{31} \\ h_{32} \\ h_{33} \end{bmatrix} = \begin{bmatrix} 0.0 \\ 0.0042 \\ 1.536 \\ -0.0058 \\ 0.0147 \\ -1.757 \\ 0.0 \\ 0.0 \\ 0 \end{bmatrix} \tag{6}$$

So when we apply it to the homogaphy matrix as we listed above in **2**:

$$\begin{bmatrix} 1 & 0.0042 & 1.536 \\ -0.0058 & 1.0147 & -1.757 \\ 0.0 & 0.0 & 1 \end{bmatrix} \tag{7}$$

The work for this can be found below:

```
%xs ys 1 0 0 0 -xd.xs -xd.ys -xd;
%0  0  0 xs ys 1 -yd.xs -yd.ys -yd;

A = [
    % first point - (105, 210) -> (140, 135)
    105 210 1 0 0 0 -140*105 -140*210 -140;
    0   0   0   105 210 1 -135*105 -135*210 -135;

    %second point - (105, 404) -> (107, 246)
    105 404 1 0 0 0 -107*105 -107*404 -107;
    0   0   0 105 404 1 -246*105 -246*404 -246;
```

```
    %third point - (490, 210) -> (460, 130)
    490 210 1 0 0 0 -460*490 -460*210 -460;
    0   0   0 490 210 1 -130*490 -130*210 -130;

    %fourth point - (420, 210) -> (496,246)
    420 210 1 0 0 0 -496*420 -496*210 -496;
    0   0   0 420 210 1 -246*420 -246*210 -246;
]

syms h11 h12 h13 h21 h22 h23 h31 h32 h33

h = [h11; h12; h13; h21; h22; h23; h31; h32; h33;]

solve(A*h==[0; 0; 0; 0; 0; 0; 0; 1;], h)
```