

# Augmented Reality - Homework 3

## Özlem Sevri

### Part 1

I implemented the desired items for part 1 in the scene named part1 and printed them to the console.

#### 1.1

We are asked to write a C# function that given a set of point correspondences  $S_i = [x_i \ y_i]^T$  and  $I_i = [u_i \ v_i]^T$  calculates the corresponding homography matrix.

I used  $A * h = 0$  formula to calculate homography matrix. I created matrix A using 2 equations for each point. Then I applied SVD(Singular Value Decomposition) to the A matrix and took the last row of the VT matrix from here and found the 3x3 homography matrix.(Ref: <https://ros-developer.com/2017/12/26/finding-homography-matrix-using-singular-value-decomposition-and-ransac-in-opencv-and-matlab/>)

Homography Matrix :

```
0,577350269189627  -3,90925237209274E-16  7,51752063945007E-16
7,3880254445041E-16  0,577350269189626  -1,28726473870844E-15
2,88944740545985E-16  -7,93181640714469E-17  0,577350269189625
```

## 1.2

We are asked to write another C# function that does the same thing as 1.1. However, the list of points on the marker and the image are not guaranteed to match.

I did not implement this part.

## 1.3

We are asked to write another C# function that given a scene point  $[x_i \ y_i]$  and a homography matrix, calculates the projection of the given point onto the target image.

I used the formula  $(u,v,1) = (x,y,1) * \text{homography matrix}(3 \times 3)$ .

```
[19:23:49] Applying Projection  
UnityEngine.Debug:Log (object)  
[19:23:49] (x,y) : 4 , 10 , 1  
UnityEngine.Debug:Log (object)  
[19:23:49] (u,v) : 4 , 10 , 1  
UnityEngine.Debug:Log (object)
```

## 1.4

We are asked to write another C# function that given an image point  $[u_i \ v_i]$  and a homography matrix, calculates the projection of the given point onto the scene.

I repeated the same process as in **1.3** using the inverse homography matrix. I used the formula  $(x,y,1) = \text{Inverse homography matrix}(3 \times 3) * (u,v,1)$ .

```
[19:23:49] Applying Inverse Projection  
UnityEngine.Debug:Log (object)  
[19:23:49] (u,v) : 5 , 3 , 1  
UnityEngine.Debug:Log (object)  
[19:23:49] (x,y) : 5 , 3 , 1  
UnityEngine.Debug:Log (object)
```

## 1.5

We are asked to find at least five point correspondences in three images manually. Show the calculated matrices for each image using these point matches. Calculate the error for another 3 point matches you identify.

I referenced some points on a 700x900 picture and manually determined the points matching these points on other pictures. I compared the homography results with the measurement and found the error rate according to the distance of the points from the origin.

For image 1:

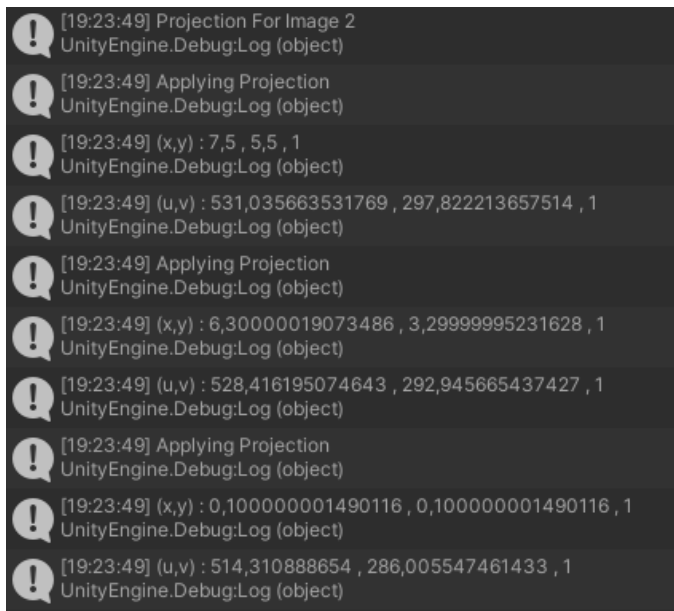
```
Calculated Homography Matrix :  
-0,0031161902494851 -8,16309522819019E-05 -0,738587588814459  
0,00011958727221196 -0,00326360939909998 -0,67414094277978  
1,05322751235532E-07 -3,85678978309085E-08 -0,00140718318310882
```

```
[19:23:49] Applying Projection  
UnityEngine.Debug:Log (object)  
[19:23:49] (x,y) : 800 , 300 , 1  
UnityEngine.Debug:Log (object)  
[19:23:49] (u,v) : 2439,89540353309 , 1167,14827295943 , 1  
UnityEngine.Debug:Log (object)  
[19:23:49] Error : %2,341305  
UnityEngine.Debug:Log (object)
```

## 1.6

We are asked to find the projection of the following scene points onto the image.

I calculated the correspondences of the desired points for all images by using the function that I wrote before and printed them on the console.

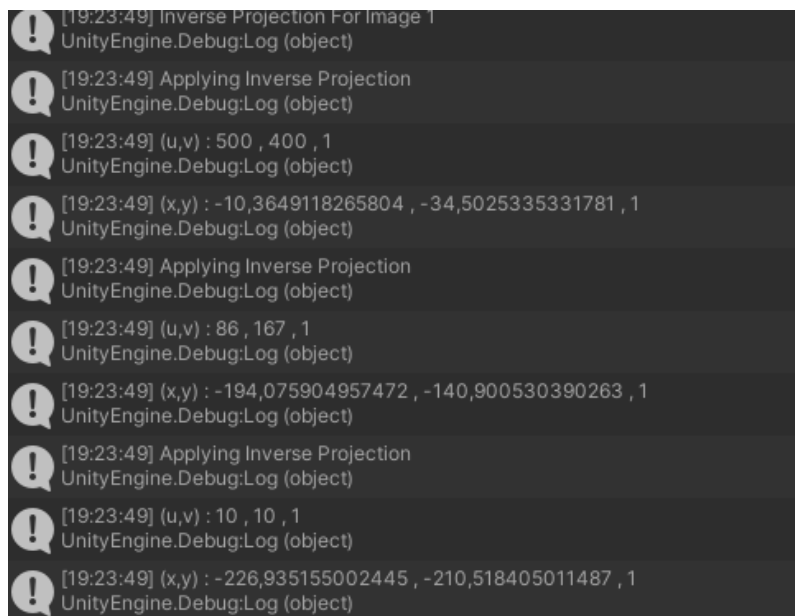


```
[19:23:49] Projection For Image 2
UnityEngine.Debug:Log (object)
[19:23:49] Applying Projection
UnityEngine.Debug:Log (object)
[19:23:49] (x,y) : 7,5 , 5,5 , 1
UnityEngine.Debug:Log (object)
[19:23:49] (u,v) : 531,035663531769 , 297,822213657514 , 1
UnityEngine.Debug:Log (object)
[19:23:49] Applying Projection
UnityEngine.Debug:Log (object)
[19:23:49] (x,y) : 6,30000019073486 , 3,29999995231628 , 1
UnityEngine.Debug:Log (object)
[19:23:49] (u,v) : 528,416195074643 , 292,945665437427 , 1
UnityEngine.Debug:Log (object)
[19:23:49] Applying Projection
UnityEngine.Debug:Log (object)
[19:23:49] (x,y) : 0,100000001490116 , 0,100000001490116 , 1
UnityEngine.Debug:Log (object)
[19:23:49] (u,v) : 514,310888654 , 286,005547461433 , 1
UnityEngine.Debug:Log (object)
```

## 1.7

We are asked to find the projection of the following image points onto the scene.

I calculated the correspondences of the desired points for all images by using the function that I wrote before and printed them on the console.



## Part 2

I did not implement this part.