TTK4255 - Assignment 3 written by Dinosshan Thiagarajah

1 Homography from observing a planar object

Task 1 a)

Using the definition of homogenous image coordinates and equations (4)-(5)

$$x = \frac{\tilde{x}}{\tilde{z}} = \frac{r_{11}X + r_{12}Y + t_x}{r_{31}X + r_{32}Y + t_z}$$
$$y = \frac{\tilde{y}}{\tilde{z}} = \frac{r_{21}X + r_{22}Y + t_y}{r_{31}X + r_{32}Y + t_z}$$

from this we get:

$$\tilde{x} = r_{11}X + r_{12}Y + t_x$$
$$\tilde{y} = r_{21}X + r_{12}Y + t_y$$
$$\tilde{z} = r_{31}X + r_{12}Y + t_z$$

which can be written in matrix form:

$$\begin{bmatrix} \tilde{x} \\ \tilde{y} \\ \tilde{z} \end{bmatrix} = \begin{bmatrix} r_{11} & r_{12} & t_x \\ r_{21} & r_{22} & t_y \\ r_{31} & r_{32} & t_z \end{bmatrix} \begin{bmatrix} X \\ Y \\ 1 \end{bmatrix} = \mathbf{H} \begin{bmatrix} X \\ Y \\ 1 \end{bmatrix}$$

Task 1 b)

Given transformation of points in 3D from camera 1 to camera 2 as:

$$X_2 = HX_1$$

In the image planes, using homogenous coordinates, we have

$$\lambda_1 x_1 = X_1, \lambda_2 x_2 = X_2, \text{therefore } \lambda_2 x_2 = H\lambda_1 x_1$$

This means that x_2 is equal to Hx_1 up to a scale (due to universal scale ambiguity), and not exactly equal

ref: https://cseweb.ucsd.edu/classes/sp04/cse252b/notes/lec04/lec4.pdf (https://cseweb.ucsd.edu/classes/sp04/cse252b/notes/lec04/lec4.pdf)

2 The Direct Linear Transformation

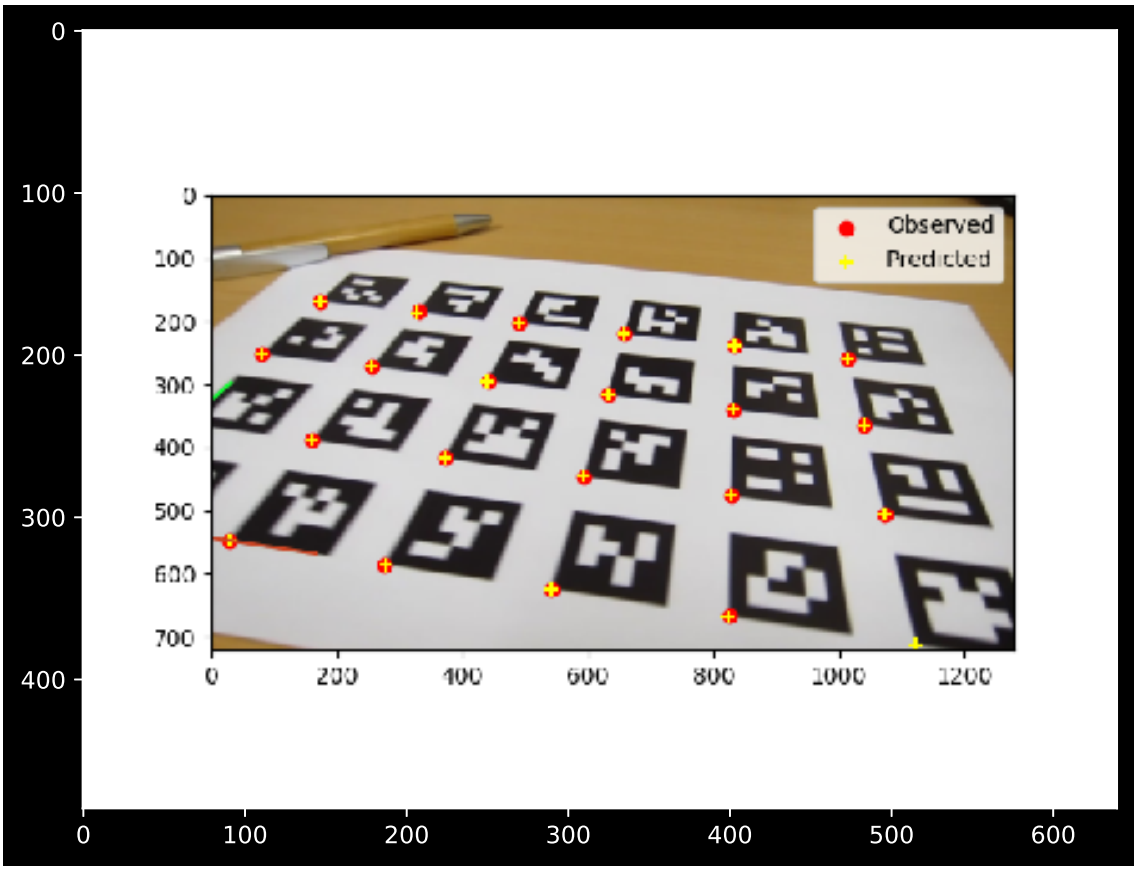
Task 2 a)

In [6]:

```
import matplotlib.pyplot as plt
plt.figure(figsize=(8,6))
plt.imshow(plt.imread("data/out0008.png"))
```

Out[6]:

```
<matplotlib.image.AxesImage at 0x7fc89adf9780>
```



3 Extracting R, t from H

Task 3 a)

Task 3 b)

z-component of translation **t** should be positive in order to observe objects in front of the camera.

Task 3 c)

Coordinate frame axes on image 5 is shown below. It satisfies the right hand rule,
which means correct tranformation matrix was chosen in 3 b)

In [1]:

```
import matplotlib.pyplot as plt
plt.figure(figsize=(8,6))
plt.imshow(plt.imread("data/out0005.png"))
```

Out[1]:

```
<matplotlib.image.AxesImage at 0x7fc8712a1a20>
```