Exercise on Camera Model & Homogenous Coordinates

February 11, 2019

In this exercise, we will work with a few assignments related to projective camera model and homogeneous coordinates.

1 Homogeneous Coordinates

Q1: Transforming the following homogeneous coordinates to their corresponding inhomogeneous coordinates

$$\begin{bmatrix}3\\4\\1\end{bmatrix}, \quad \begin{bmatrix}4\\6.5\\0.5\end{bmatrix}, \quad \begin{bmatrix}5\\2\\0.1\end{bmatrix}, \quad \begin{bmatrix}10\\100\\20\end{bmatrix}, \quad \begin{bmatrix}0.1\\0.2\\100\end{bmatrix}$$

Q2: Transforming the following homogeneous coordinates to their corresponding inhomogeneous coordinates

$$\begin{bmatrix}3\\4\\1\\0.1\end{bmatrix}, \quad \begin{bmatrix}4\\6.5\\0.5\\2\end{bmatrix}, \quad \begin{bmatrix}5\\2\\0.1\\3\end{bmatrix}, \quad \begin{bmatrix}10\\100\\20\\1\end{bmatrix}, \quad \begin{bmatrix}0.1\\0.2\\100\\10\end{bmatrix}$$

Q3: Find the line which passes the following two 2D points:

$$\mathbf{p}_1 = (1, 2)^T, \ \mathbf{p}_2 = (5, 3.5)^T$$

Q4: Compute the distance of point $\mathbf{p}_1 = (7.5, 3.6)^T$ to the line you find in **Q3**.

Q5: Find the intersection of two lines given as

$$\mathbf{l}_1 = [1,\ 1,\ -1]^T, \ \mathbf{l}_2 = [-1,\ 3,\ -4]^T,$$

2 2D Transformation

To give your an better illustration of 2D transformation, we will work with a simple square. The square can be generated using the following code:

Listing 1: Sample code from Matlab

```
x = 0:0.1:5;
y = 0:0.1:5;
pt = [x repmat(x(end), 1, numel(y)) fliplr(x) repmat(x(1), 1, numel(y)); repmat(y(1), 1, ...
     numel(y)) y repmat(y(end), 1, numel(y)) fliplr(y)];
pt = [pt;ones(1,size(pt,2))];
```

Q6: Given a matrix $\mathbf{A}$ given as

$$\mathbf{A} = \begin{bmatrix} 0.8660 & 0.5000 & 2.0000 \\ -0.5000 & 0.8660 & -2.0000 \\ 0 & 0 & 1.0000 \end{bmatrix}$$

By applying the transformation of $\mathbf{A}$ to the square, what will you get, plot them in one figure and explain what is the effect by multiplying the matrix A? Are there any invariants conserved?

Q7: Try with **A** as

$$\mathbf{A} = \begin{bmatrix} 0.1732 & 0.1000 & 2.0000 \\ -0.1000 & 0.1732 & -2.0000 \\ 0 & 0 & 1.0000 \end{bmatrix}$$

Plot and explain what is the effect by multiplying the matrix A? Are there any invariants conserved?

Q8: Try with another **A** as

$$\mathbf{A} = \begin{bmatrix} 0.5000 & 0.3000 & 2.0000 \\ 0.1000 & 1.2000 & -2.0000 \\ 0 & 0 & 1.0000 \end{bmatrix}$$

Plot and observe which invariant is still preserved?

3 Inverse Perspective Mapping

Q9: Here you will work on how to remove the perspective effect by using the vanishing line and 2D transformation. Use the following code to load and display the image you will work:

```
clc;close all;clear all;
I = imread('Tiles_perspective_distort.png');
I = im2double(I);
h = figure;
imshow(I);
[x,y] = ginput(4);
q = round([x y]');
q = [q;ones(1,4)];
I = drawlines(I,q,[[1 2];[3 4];[1 4];[2 3]]);
imshow(I);
```

Then click on the displayed image to obtain the coordinates of four points you clicked. **q** will contain their homogeneous coordinates. You should work from here.

In this attachment, you will find two supplementary files.

- **drawlines.m** - draw lines on image I.
- **warpping.m** - warp image I by transformation matrix **H**. So after you find **H**, call this function to get the resultant image.

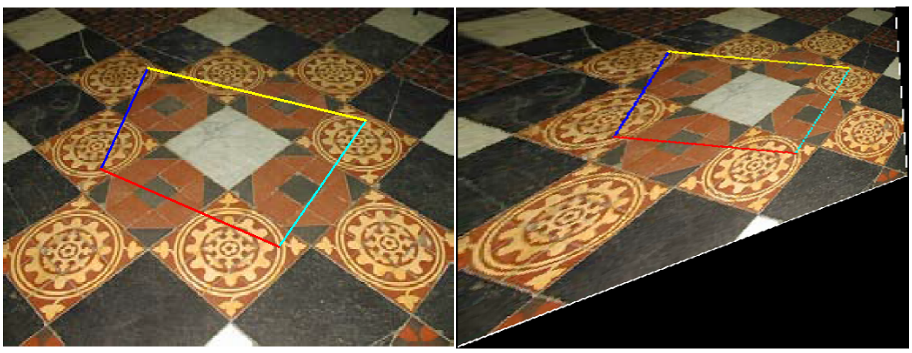

Figure 1: Illustration of the inverse perspective mapping.