Introduction to Computer Vision, CSE 527

Homework Assignment 3

Ankit Arun(109914679)

October 24, 2014

Problem 1. Pinhole Camera Model

In this question given that focal length of the camera, f = 8mm.

$$k_u = \frac{800}{4} = 200 pixel/mm$$

$$k_v = \frac{600}{3} = 200 pixel/mm$$

$$u_o = 400 pixels$$

$$v_o = 300 pixels$$

a)

The intrinsic parameter matrix A would be

```
A =

        1600            0          400
           0         1600          300
           0            0            1
```

b)

The quaternion matrix for the rotation about the axis (3,4,-1) by 60 degrees can be represented as.

$$q = \cos\frac{\Theta}{2} + (u_x\hat{i} + u_y\hat{j} + u_z\hat{k})\sin\frac{\Theta}{2}$$

So, for the given question

$$\Theta = 60^\circ$$

and (3,4,-1) is our axis.

$$q = \cos\frac{60}{2} + (3\hat{i} + 4\hat{j} + (-1)\hat{k})\sin\frac{60}{2}$$

$$q = \frac{\sqrt{3}}{2} + (3\hat{i} + 4\hat{j} + (-1)\hat{k})\frac{1}{2}$$

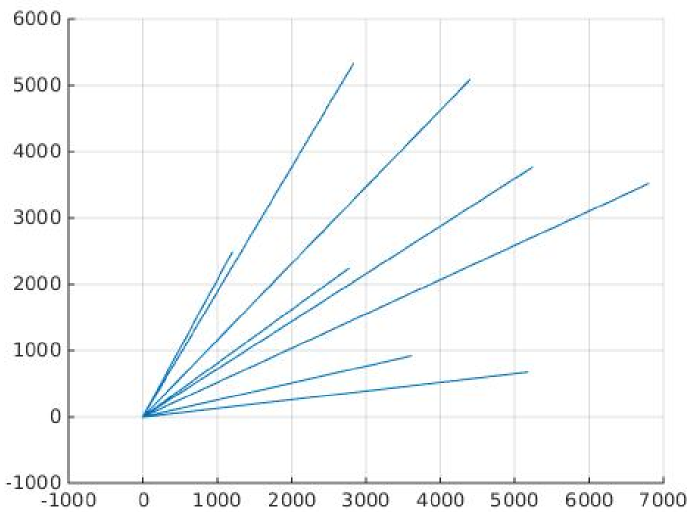
Using Matlab to determine the transfromation matrix M

```
M =

    0.6731    0.4006    0.6217         0
    0.0609    0.8077   -0.5864         0
   -0.7371    0.4326    0.5192   10.0000
         0         0         0    1.0000
```

c)

Considering the cube centered and axis-aligned with the camera's frame of reference.

```
P =

     1    -1    -1     1     1    -1    -1     1
     1     1    -1    -1     1     1    -1    -1
     1     1     1     1    -1    -1    -1    -1
     1     1     1     1     1     1     1     1


newP =

   1.0e+03 *

  Columns 1 to 8

    6.7985    5.2343    3.6063    5.1705    4.3937    2.8295    1.2015    2.7657
    3.5159    3.7632    0.9190    0.6717    5.0810    5.3283    2.4841    2.2368
    0.0102    0.0117    0.0108    0.0093    0.0092    0.0107    0.0098    0.0083
```



d)

The points at infinity in the new frame of object would project at the vanishing point in the image. If we cansider very large values for x,y and z then the vanishing point in homogeneous co-ordinate system would be:

```
U =

   1.0e+20 *

    1.6954
    0.2822
    0.2148
    0.0000
```

Problem 2. Camera Calibration

a)

Persrective Projection Camera Model

The intrinsic parameter matrix for perspective Projection Camera Model would be:

$$K = \begin{bmatrix} \alpha & s & u_0 \\ 0 & \beta & v_0 \\ 0 & 0 & 1 \end{bmatrix}$$

The extrinsic parameter matrix for perspective Projection Camera Model would be:

$$P = \begin{bmatrix} r_{11} & r_{12} & r_{13} & t_x \\ r_{21} & r_{22} & r_{23} & t_y \\ r_{31} & r_{32} & r_{33} & t_z \end{bmatrix}$$

Projective Camera Model

Since in this problem the ray is passing through one axis(say X) we can consider other axis(Y and Z) to be zero. So, considering this factor the projective camera model will reduce to a 3X2 matrix, which is:

$$P2 = \begin{bmatrix} p_{11} & p_{12} \\ p_{21} & p_{22} \\ p_{31} & p_{32} \end{bmatrix}$$

b)

There are 5 degrees of freedom in order to calbrate this system.

c)

Calculating the eigenvector and eigenvalues through SVD. The eigenvector corresponding to smallest eigenvalue is:

$$\begin{bmatrix} -0.0013 \\ 0.3818 \\ -0.0033 \\ 0.9242 \\ -0.0000 \\ 0.0029 \end{bmatrix}$$

The calibration parameters for this problem is :

$$\begin{bmatrix} -0.4625 & 130.9076 \\ -1.1371 & 316.8832 \\ -0.0040 & 1.0000 \end{bmatrix}$$

d)

a) The first point is (130,310). Corresponding table height is : 137.4421 mm

b) The second point is (170,380). Corresponding table height is : 234.7793

c) The third point is (190,300). Corresponding table height is : 270.7898

Problem 3. Image mosaicing

The codes are placed in the folder Problem 3. main2.m is the driver function. The two functions are ComputeWarpMapping and WarpImage. The merged image is in the folder Solution Image.