CSE473/573 Summer 2018 - Homework 2

Submit by 11.59 PM, June 11th

June 5, 2018

"Brevity is the soul of wit" - Shakespeare
A good piece of writing, or a good speech should be brief and concise.

1 Camera Calibration - 30%

http://www.pauldebevec.com/Thesis/debevec-phdthesis-1996_ch4_calib.pdf (from the thesis of the guy who talked about Light Stage in HW1 first video). Use this document as your primary reference to answer questions below:

1. Report the camera parameters estimated in the classroom activity (A snapshot of your results will do). Read through section 4.1 in the document and give an intuitive explanation of each parameter in the intrinsic camera matrix that you estimated - 10%
2. How do real cameras deviate from pinhole cameras? (Section 4.2) - 10%
3. Explain briefly how to work with uncalibrated images (Section 4.6) - 10%

2 Perspective Projection - 40%

A camera comprises a lens of focal length 20mm and a 10mmx10mm CCD Array. The CCD Array is divided into 500x500 square pixels. The pixel at top left corner of the CCD array has co-ordinates (0, 0) and the optical axis intersects the CCD array at pixel co-ordinates (200, 200). This camera configuration in real world is shown in Fig. 1. Assume pinhole model and answer the questions below

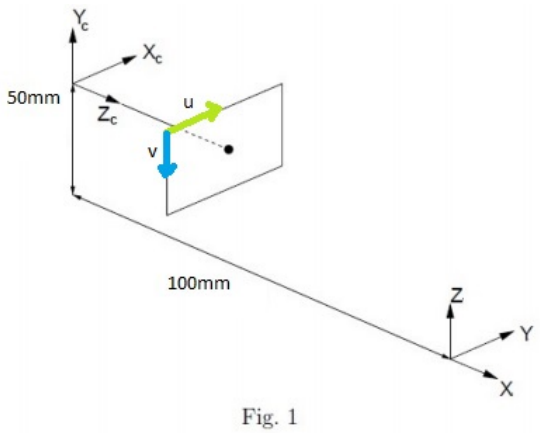

Fig. 1

Inspection of the figure reveals that

$$X_c = -Y$$

The rigid body transformation between world and camera coordinates is therefore

$$\begin{bmatrix} X_c \\ Y_c \\ Z_c \\ 1 \end{bmatrix} = \begin{bmatrix} 0 & -1 & 0 & 0 \\ & & & \end{bmatrix} \begin{bmatrix} X \\ Y \\ Z \\ 1 \end{bmatrix}$$

1. . Fill in the missing values of 4x4 matrix above. This is the extrinsic parameter matrix and provides the mapping between real word co-ordinate system and the camera co-ordinate system - 10%

2. Derivation - If the image plane is sampled by a CCD array with k_u pixels per unit length in the u direction and k_v pixels per unit length in the v direction, show that the relationship between a point (Xc, Yc, Zc) and its image (u, v) (in pixels) is given by - 10%

$$\begin{bmatrix} su \\ sv \\ s \end{bmatrix} = \begin{bmatrix} k_u f & 0 & u_0 & 0 \\ 0 & k_v f & v_0 & 0 \\ 0 & 0 & 1 & 0 \end{bmatrix} \begin{bmatrix} X_c \\ Y_c \\ Z_c \\ 1 \end{bmatrix}$$

3. . Calculate the 3x4 Perspective projection Matrix which relates homogeneous pixel coordinates (su, sv,s) to world coordinates (X, Y, Z) - 10%

4. What is Ames Room Illusion? Describe the physics behind it - 10%

3 Color Imaging - 30%

1. What is Gamma Correction and why is it needed? 5%

2. Explain the key steps of demosaicing bayer filtered images 10%

3. Briefly explain what linear color spaces are. Is RGB a linear color space?
   https://www.pyimagesearch.com/2014/06/30/super-fast-color-transfer-images/ -
   Go through this tutorial and implement color transfer between two images of your choice and report your results.

   After successfully implementing previous step, modify the code to skip the color space conversion step (directly use RGB images), run the code and report your results 15%