EECS 531 - Computer Vision - Assignment 5

In this assignment, you we geometric computer vision.

Exercise 1: Construct a virtual world.

a) Define a small set of points in the 3D world coordinates and show them with 3d plot.
b) Specificity a camera with the following fields:
   - **position:** the location of the camera
   - **target:** the focal point of the camera
   - **up:** the up direction of the camera
   - **focal_length**: the distance between the camera center and the image plane
   - **film_width**, **film_height**: the sensor width and height
   - **width, height**: the number of horizontal and vertical pixels

   All of these parameters should be in the world coordinate system with consistent units. You can use the provided function to plot the camera position and focal plane. Make sure the points defined in a) are in the field of view.
c) Add a second camera with a different position but the same target. Make a plot showing the points and the cameras.

Exercise 2: Generate the image pairs.

a) Construct the extrinsic matrix that describes the Euclidean transformation from the world coordinates to the camera coordinates.
b) Construct the intrinsic matrix(calibration matrix) that describes the projection from the camera coordinates to the pixel space.
c) Construct the camera matrix with the extrinsic matrix and the intrinsic matrix.
d) Generate the pair of images captured by the two cameras defined in exercise 1.

Exercise 3: Triangulation.

a) Implement the linear triangulation method to recover the 3D positions in world coordinates from corresponding point pairs in 2D pixel coordinates given the parameters of the cameras.
b) Plot the recovered positions and illustrate how closely they correspond to the original points.

Important Dates

- Mon Apr 23 - Group discussions. Discussion summaries are due by midnight.
- Mon Apr 30 - Group presentations.
- Wed May 2 - Final notebooks are due before midnight. Submit all notebooks (or pdfs) to Canvas.
- Fri May 4 - Peer evaluations are due before noon.

Requirements

- You are required to use git to manage your code and notebook and make commits regularly to show your progress. You must make a submission of your code and notebooks to canvas before each group discussion, group presentations, and the final due date.
- Use one jupyter notebook (or latex-generated pdf file) per exercise.
- Each notebook should include all necessary text, math, code, and results for clearly explaining your work to others. In addition to submitting the notebooks (the .ipynb files) you should also submit the export of the notebook to a pdf file.
- If you are using a language that does not support jupyter, you must create a pdf notebooks using latex. Use separate pdfs for each notebook.
- After the discussion session, you should submit your feedback to others' work on canvas in their submission page.

Group Discussions. The goal of this discussion is for each member of the group to have a clear idea of how to approach all the exercises in the assignment. You are free to ask any questions and offer any help

that helps toward completing the assignment. A good outcome would be for everyone to have gotten a good start on the first two exercises.

Group Presentations. Each member of the group will have 7-8 min to present their notebooks to the other members of the group. Group members should take notes on each presentation for peer review of the final submission (due the following Monday via Canvas). Students are expected to use the feedback from the group to improve their notebooks before final submission. An group selected moderator will ensure that everyone stays within the time limits and that feedback is constructive.

Peer Evaluations. Group members are responsible for evaluating each of the other group members on completeness, clarity and depth understanding, correctness, thoroughness, and creative exploration. As well as a brief summary. Criteria are scored on a scale of 0-3. Details are in the rubric.