Lab 2: Image Transformations

Due   Sep 9, 2020 by 4pm   **Points**   10
Submitting   a text entry box, a website url, a media recording, or a file upload
Available   after Sep 4, 2020 at 3pm

This is a lab assignment to be done during class, in teams of two, that will be graded on a complete/incomplete basis, and must be turned in before the next class for credit.

1. Consider a rotation about the X axis of 1.1 radians, followed by a rotation about the Y axis of -0.5 radians, followed by a rotation about the Z axis by 0.1 radians (this order of rotations is called the "XYZ fixed angles" convention).

   a. Give the 3x3 rotation matrix corresponding to the rotations above.

   b. Since the rotation matrix is "orthonormal" matrix (i.e., a square matrix whose rows and columns are orthogonal unit vectors), its inverse is equal to its transpose. Show this.

   c. Give the 3x3 rotation matrix where the same rotations described in part (a) are done in the opposite order; i.e., first a rotation about the Z axis of by 0.1 radians, followed by a rotation about the Y axis of -0.5 radians, followed by a rotation about the X axis by 1.1 radians (this convention is called "ZYX fixed angles"). The matrix should be different.

2. A camera observes the following 7 points, defined in WORLD coordinates (meters):

6.8158	7.8493	9.9579	8.8219	9.5890	10.8082	13.2690
−35.1954	−36.1723	−25.2799	−38.3767	−28.8402	−48.8146	−58.0988
43.0640	43.7815	40.1151	46.6153	42.2858	56.1475	59.1422

The pose of the camera with respect to the world is given by the following:
- Translation of camera origin with respect to the world is (10,-25,40) in meters.
- Orientation of the camera with respect to the world is given by the angles provided in problem #1.

   a. Compute the homogeneous transformation matrix that represents the pose of the camera with respect to the world, $^{w}_{c}H$, assuming that the convention being used is "XYZ fixed angles".

   b. Compute the homogeneous transformation matrix that represents the pose of the world with respect to the camera, $^{c}_{w}H$.

   c. Assume that the size of the image is 256 columns (width) by 170 rows (height), with the optical center at the image center. The effective focal length is 400 pixels. Write the intrinsic camera calibration matrix K.

   d. Create a blank (zeros) image, and project the 7 points to the image. Write white dots into the image at those points.

3. Using OpenCV's "line" function, draw lines between the points on the image. Namely draw a line from point 0 to point 1, another line from point 1 to point 2, and so forth. Show the resulting image (hint: it should be a familiar object).

Post the answers to the above questions on Canvas, along with the Python code you used to compute the answers. Each person on the team should post the answers and code.