

**Prof. J. Elder**

**Due Date:** 11:59pm Monday Dec 3rd, 2018.

**General Guidelines:**

For this assignment you will submit via Moodle a carefully formatted assignment report. You do not have to submit your MATLAB code. Your report must be submitted as an Adobe Acrobat (.pdf) file. Your report should be well organized and address both questions below.

Points will be awarded in part for the clarity and formatting of your report.

1. (50 marks) Use one of the provided checkerboard rigs and the MATLAB camera calibrator app to geometrically calibrate your camera. Report the make and model of your camera/phone and the estimated camera parameters and uncertainties in tabular format.
2. (50 marks) You are provided with dimensions of York's LSB building as well as an image of that building taken with a Sony NEX-6 camera, which automatically corrects for radial distortions. The intrinsic parameters of the camera are as follows:
  - Focal length: 15.688 mm
  - Principal point:  $(c_x, c_y) = (2459.0, 1629.6)$  pixels (relative to top left corner of image)
  - Pixel size: 4.7827 microns

You can assume square pixels and zero skew.

Assume a world coordinate frame anchored at the nearest corner of the building, as shown in Fig. 1. Use this information to determine the extrinsic parameters (3D rotation and 3D translation) of the camera. Express the translation in metres and the rotation as a unit vector  $\hat{\mathbf{n}} = (\hat{n}_x, \hat{n}_y, \hat{n}_z)$  axis of rotation and angle  $\theta$  of rotation in degrees (right hand rule). Report your results in tabular format.

**Useful MATLAB functions:** xlsread, size, ones, zeros, repmat, svd, reshape, sign, det, qr, flipud, fliplr, diag, figure, imagesc, axis, hold, plot, hold, legend, rotationMatrixToVector, rotationVectorToMatrix, optimoptions, lsqnonlin

3. (20 bonus marks). Estimate your uncertainty in these parameters by bootstrapping. Report the results in tabular format.

**Useful MATLAB functions:** size, unidrnd, zeros, unique, rotm2axang, sqrt, sum



Figure 1: Question 2-3: World coordinate frame.