

Assignment-1: Camera Calibration

The goal of this assignment is to find intrinsic and extrinsic camera calibration parameters of your mobile phone's camera. Intrinsic calibration parameters include focal length, skew, radial distortion parameters, other distortion parameters, camera's optic center. Extrinsic calibration parameters include Rotation, Translation (and/or scale) computation for every photo taken by the mobile phone. You will calibrate your own camera using a checkerboard object. Print two (or three) copies of the checkerboard image and stick them to two (or three) orthogonal planes (wall corner). Click a picture of the checkerboard from your phone. Camera calibration requires 2D and 3D correspondences. Create a dataset that contains XYZ coordinates of N points marked out on the wall checkerboard and also the XY coordinates of the corresponding points on the image. Now, write a program that estimates the 3×4 projection matrix P and then decompose it into the intrinsics and extrinsics.

Your code should follow the following steps:

- Normalize the data such that the centroid of 2D and 3D points are at origin and the average Euclidean distance of 2D and 3D points from the origin is $\sqrt{2}$ and $\sqrt{3}$, respectively. Find the transformation matrices T and U that achieve this for 2D and 3D respectively, i.e., $\hat{x} = Tx$ and $\hat{X} = UX$ where x and X are the unnormalized 2D and 3D points in homogeneous coordinates.
- Estimate the normalized projection matrix \hat{P} using the DLT method. Denormalize the projection matrix \hat{P} . ($P = T^{-1}\hat{P}U$).
- Decompose the projection matrix $P = K[R | -RX_o]$ into intrinsic matrix K , rotation matrix R , and the camera center X_o . K and R can be estimated using RQ decomposition.

- Verify that the projection matrix is correctly estimated by computing the RMSE between the 2D points marked by you and the estimated 2D projections of the marked 3D points. Visualize the points on the image and include them in the report. Also mention why it is a good idea to normalize the points before performing DLT.

NOTE: Use of any already existing calibration toolbox and library is prohibited. Students shall use libraries for computing mathematical functions and evaluations, and performing operations (such as read/write/matching, etc) on images only. Students can form groups of upto 2 students. Please fill the sheet shared as soon as possible if not already done.

Submissions will be done on moodle in the form of a pdf report and a zip containing source code(with compiled source).

The deadline for this assignment is 11:59 pm @ 4 February 2022.