

Homework 5

Due November 9, 2006

This homework requires you to implement Zhengyou Zhang's camera calibration procedure.

Let's say you want to calibrate a camera at home or in your lab. You'd like to find all five of its intrinsic parameters and also find its six extrinsic parameters with respect to some world reference. Toward that end, mount the provided calibration pattern on a wall somewhere and do the following for acquiring the images you need for the camera calibration procedure:

- 1) Place the camera at a marked location on a table or a tripod and record an image of the calibration pattern. The extrinsic pose parameters you will calculate will be for this location of the camera.
- 2) Now move the camera and rotate it so that it assumes different orientations vis-a-vis the calibration pattern. Record an image of the calibration pattern for each position/orientation of the camera.

Implement the following steps for extracting corner points in each image:

- 1) Apply the Canny edge detector to the images.
- 2) Fit straight lines to the Canny edges.
- 3) Define the corners as the intersections of the fitted straight lines.

For these three steps, you will find useful some of image processing functions provided by Peter Kovesi at the following URL

<http://www.csse.uwa.edu.au/~pk/research/matlabfns/>

Show the extracted the corner points from each image as in Homework 2. Assign and display integer labels given to the corner points; the corresponding corner points in all the images should get the same integer label.

Now compute the intrinsic and the extrinsic parameters using the algorithm described in Section 3.1 of Zhang's report.

For extra credit, refine all the camera parameters by applying the nonlinear optimization (gradient descent, Gauss-Newton, or Levenberg-Marquardt) discussed in Section 3.2 of Zhang's report.

For even more credit, include radial-distortion correction parameters in your calibration procedure, as discussed in Section 3.3 of the report.

Finally demonstrate the accuracy of the estimated calibration parameters by projecting the corner points in the calibration pattern into the image plane for one or more of the camera views. By visually comparing the locations of the projected corner points vis-à-vis their actual placements, one can ascertain the accuracy of a calibration procedure.