

# Assignment A3: Camera Calibration (adapted from Prof. Gerig, Spring 2013)

*CS 6320  
Spring 2014*

**Assigned:** 6 January 2014

**Due:** 30 January 2014

For this problem, handin a lab report pdf (include name, date, assignment and class number in pdf) which studies camera calibration. You should handin the report pdf as well as the Matlab code used in the study. The code should conform to the style requested in the class materials.

In addition, please turn in a hardcopy of the report in class before the start of class on January 30, 2014.

This objective of this assignment is to calibrate a (digital) camera so as to be able to capture images of objects from known locations and with a known camera model.

## **Assignment Requirements:**

1. Calibrate your own camera with a fixed focal length with two orthogonal checkerboard planes (see Figure ). Real world coordinates are measured via a tape measure or ruler relative to a world coordinate origin of your choice and stored in a file. Corresponding pixel locations are obtained in the image, e.g., by using MATLAB function `ginput()` to acquire image positions with mouse clicking, and show clicked position with function `plot()`. This gives us the list of points in world space  $P_i = (x, y, c)^T$  and associated points in image space  $p_i = (u, v)^T$ .

2. A calibration pattern can be downloaded from [http://www.vision.caltech.edu/bouguetj/calib\\_doc/htmls/pattern.pdf](http://www.vision.caltech.edu/bouguetj/calib_doc/htmls/pattern.pdf). Best is to use two copies of the pattern and mount it into a straight corner of a wall as shown in the image.
3. Implement the LSE algorithm (discussed in class, ignore radial distortion) to calibrate the dataset, best is to use appropriate Matlab functions to solve the homogeneous overconstrained equation system (eigs, svd, etc.).
4. Extract the intrinsic and extrinsic parameters from the calibration matrix following the instructions from Prof. Gerig's slides and handouts. Hint: For simple cameras or cell phone cameras, you will need to search for the focal length in the manufacturer's instructions. E.g., the iphone has 3.85 mm fixed aperture f/2.8. Please note that using a camera's optical zooming option results in an unknown focal length, whereas a digital zoom simply reduces image quality by pixel replication. Best is to avoid using any zoom but placing the camera close enough so that the calibration pattern fills a major part of the image.
5. Reconstruct the image coordinates  $p$  from the world coordinates  $P$  using your estimate of the calibration matrix. Compare the calculated pixel locations to the measured locations and list and/or plot the differences.
6. In the lab report include the following:
  - (a) A brief description of your experimental procedure: data capturing and methods used, setup of LSE, solution strategy.
  - (b) Intrinsic parameters.
  - (c) Extrinsic parameters.
  - (d) Discussion of results: How plausible is each parameter?
7. What you should turn in (CADE lab handin):
  - (a) The lab report in a printable pdf format including descriptions, images, graphs and tables, and including also a print of the Matlab (or other) code.
  - (b) Matlab (or other) code that you used to calculate the calibration parameters.

### **Instructions:**

Hardware Preparation/Software Installation: Calibration Pattern can be downloaded at [http:](http://www.vision.caltech.edu/bouguetj/calib_doc/htmls/pattern.pdf)

[//www.vision.caltech.edu/bouguetj/calib\\_doc/htmls/pattern.pdf](http://www.vision.caltech.edu/bouguetj/calib_doc/htmls/pattern.pdf).

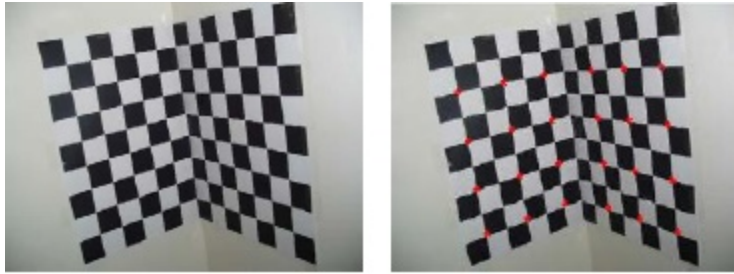


Figure 1: Checkerboard mounted on wall corner (left) and manually defined points in the camera image (right).