BONN-RHEIN-SIEG UNIVERSITY OF APPLIED SCIENCES

Scientific Experimentation and Evaluation - Assignment 04 - Camera Calibration Setup

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CONTENTS

1 Abstract

This report describes the design of the camera calibration process, including its setup, the calibration parameters and possible problems during the calibration.

2 Setup

The camera will be fixed in its position by securing it on a solid surface with some tape. The chessboard pattern used for the calibration will be fixed on a flat board. The board will be held in hands and changed in orientation with respect to the camera for every image. In the online tutorial ([2]) 20 images were sufficient, we also plan to use about 20-25 images. The orientations of the images should differ for each image and provide a good range of different orientations.

3 Camera Parameters

Matlab computes the following parameters:

- **Focal Length** (2x1 vector)
  "The focal length of an optical system is a measure of how strongly the system converges or diverges light." [3] (see figure 3.1).
- **Principal Point** (2x1 vector)
  "The principal points are the points where the principal planes cross the optical axis."[3]
  "The two **principal planes** have the property that a ray emerging from the lens appears to have crossed the rear principal plane at the same distance from the axis that that ray appeared to cross the front principal plane, as viewed from the front of the lens. This means that the lens can be treated as if all of the refraction happened at the principal planes."[3] (see figure 3.2).
- **Skew Coefficient** (scalar)
  "The skew coefficient defines the angle between the x and y pixel axes"[1]
- **Distortions** (5x1 vector)
  Matlab stores both radial and tangential distortions in the distortions vector.[1]
  Radial distortions increase or decrease magnification with the distance to the optical axis[3](see figure 3.4).
  Tangential distortion occurs when camera lens and sensor are not parallel (see figure 3.3).
- **Rotations** (set of 3x3 rotation matrices)
  Rotations from images into reference frame.[1]
- **Translations** (set of 3x1 vectors)
  Coordinate vectors of the origin of the grid pattern in camera reference frame. [1]

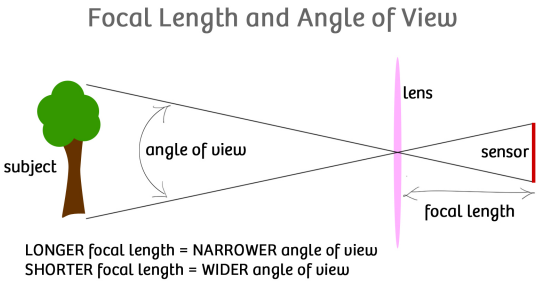

Figure 3.1: Focal Length,
http://static.snapsnapsnap.photos/wp-content/uploads/2014/11/Focal-Length-and-Angle-of-View.jpg

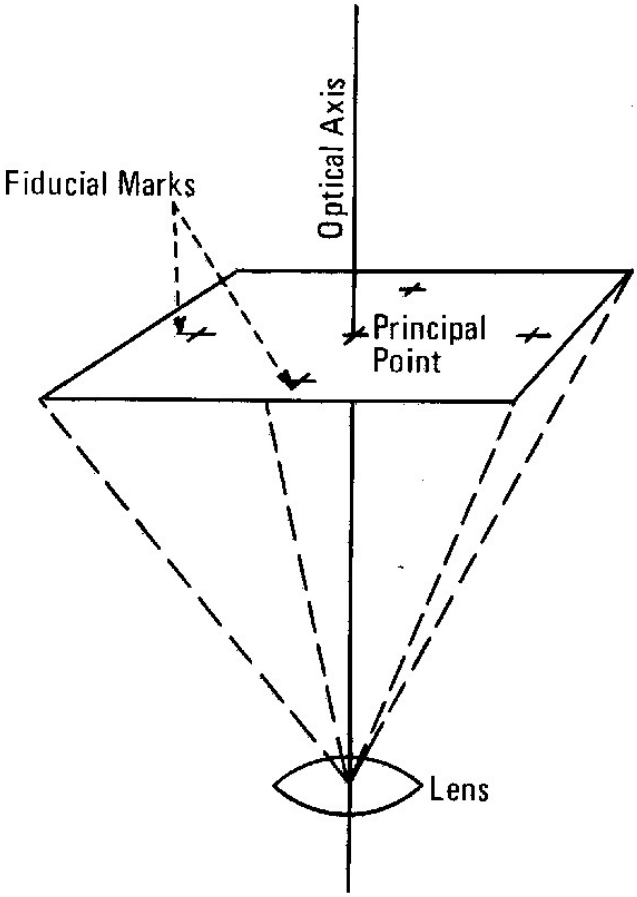

Figure 3.2: Principal Point,
http://www.fao.org/docrep/003/t0390e/T0390E48.gif

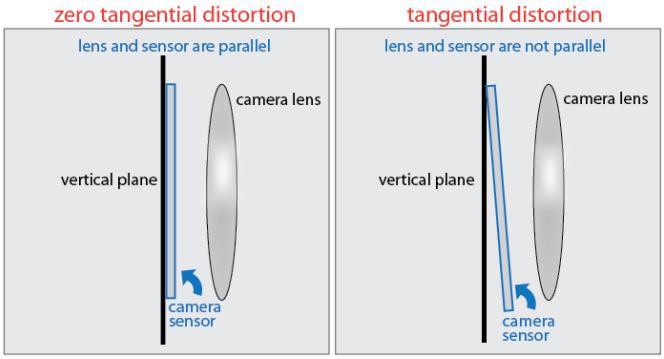

Figure 3.3: Tangential Distortion,
http://www.mathworks.com/help/vision/ref/cameracalibrator_tangentialdistortion.png

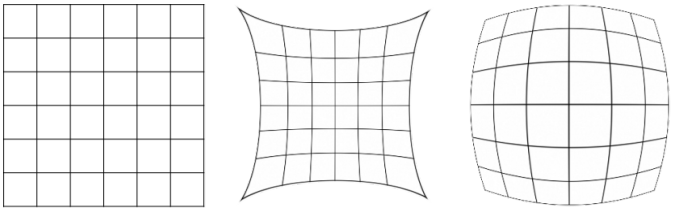

Figure 3.4: Radial Distortion,
http://www.intechopen.com/source/html/44946/media/image17.png

4 Possible Problems

One problem could be surface of the grid if it is not fixated on the plate properly. This could lead to unwanted bending of the grid. Another problem could occur if the grid is not being held still while taking the pictures. The images could become blurred and useless. If the checker board gets partly out of the image these images will become useless as well. The lighting conditions need to be good to ensure the distinction of the single checker cells.

References

[1] Description of the calibration parameters. `http://www.vision.caltech.edu/bouguetj/calib_doc/htmls/parameters.html`. Accessed: 2016-05-01.

[2] First calibration example - corner extraction, calibration, additional tools. `http://www.vision.caltech.edu/bouguetj/calib_doc/htmls/example.html`. Accessed: 2016-05-01.

[3] Wikipedia. `https://en.wikipedia.org`. Accessed: 2016-05-01.