TECHNISCHE UNIVERSITÄT BERLIN

Calibration of the Olympus UZ-500

Scanning Project
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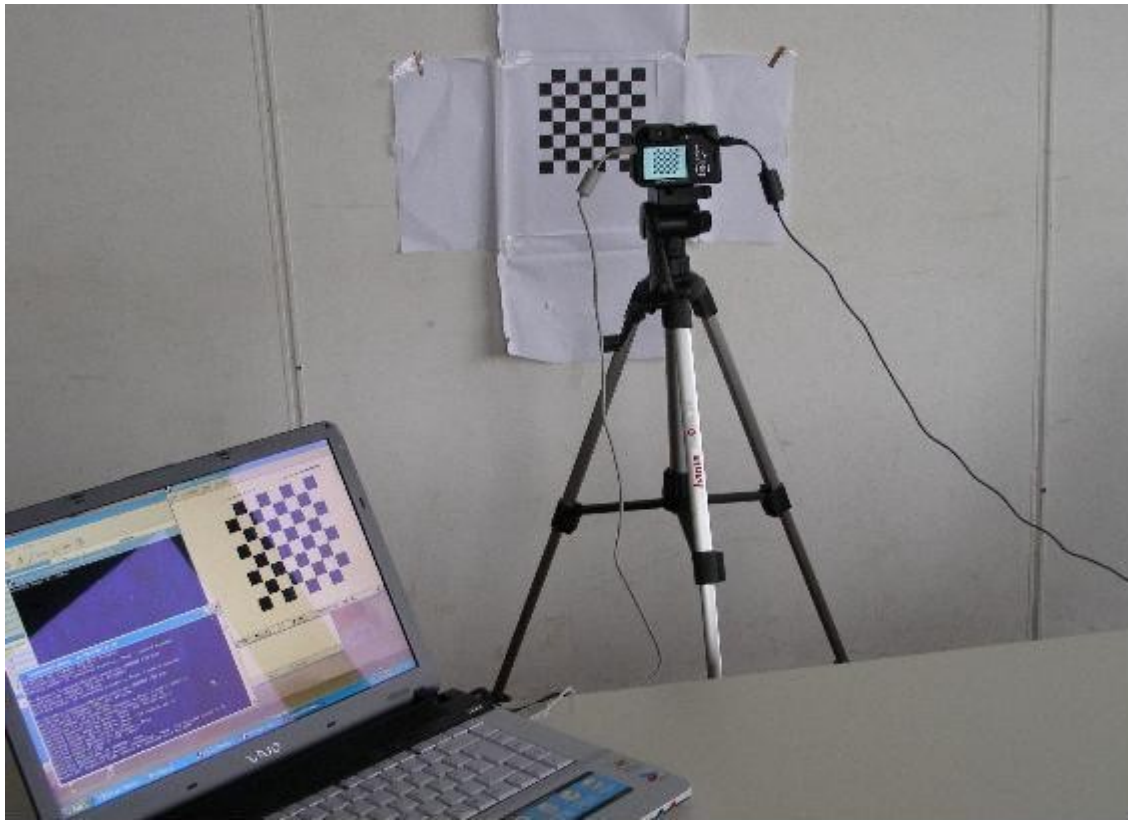
Motivation

- for scanning objects, we are going to take pictures with three cameras:
  - two Olympus UZ-500
  - one PMD camera
- the pictures from these cameras have to be matched together with features
- every camera has a distortion
- we need pictures without distortion error, because it makes the matching harder or impossible

Tsai vs Zhang

- two important calibration methods exist:
  - the Tsai algorithm
  - the Zhang algorithm
- the Tsai algorithm needs exact data about movement and position of camera and object
- the Zhang algorithm is more complex and needs more computational effort than Tsai
- the Zhang algorithm is easier to handle, because one needs no information about the positions
- we used the Zhang algorithm

Taking Pictures



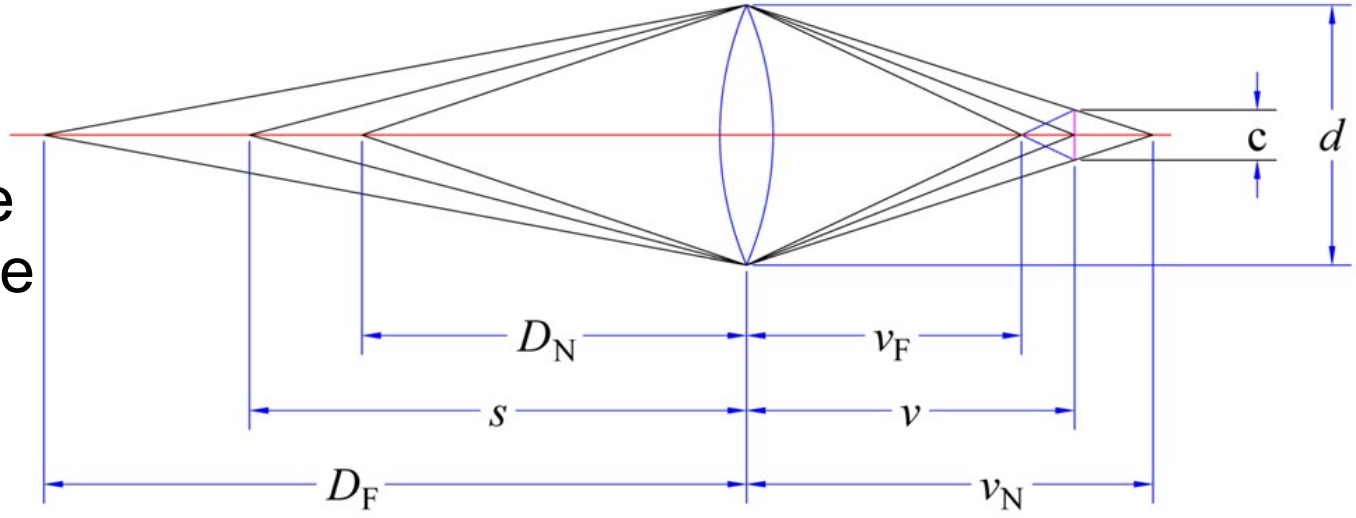
- we took with our camera pictures of a chessboard
- for every measurement 10 pictures from different views were taken
- the pictures were loaded and evaluated on an laptop

Cam Checker

- the calculation of the intrinsic parameters was done by the tool Cam Checker
- Cam Checker use the Zhang algorithm
- for every setting we loaded 10 pictures from different angles in Cam Checker
- Cam Checker calculated with correspondent points on the pictures the distortion
- the quality of the calculation depends on the quality of the pictures

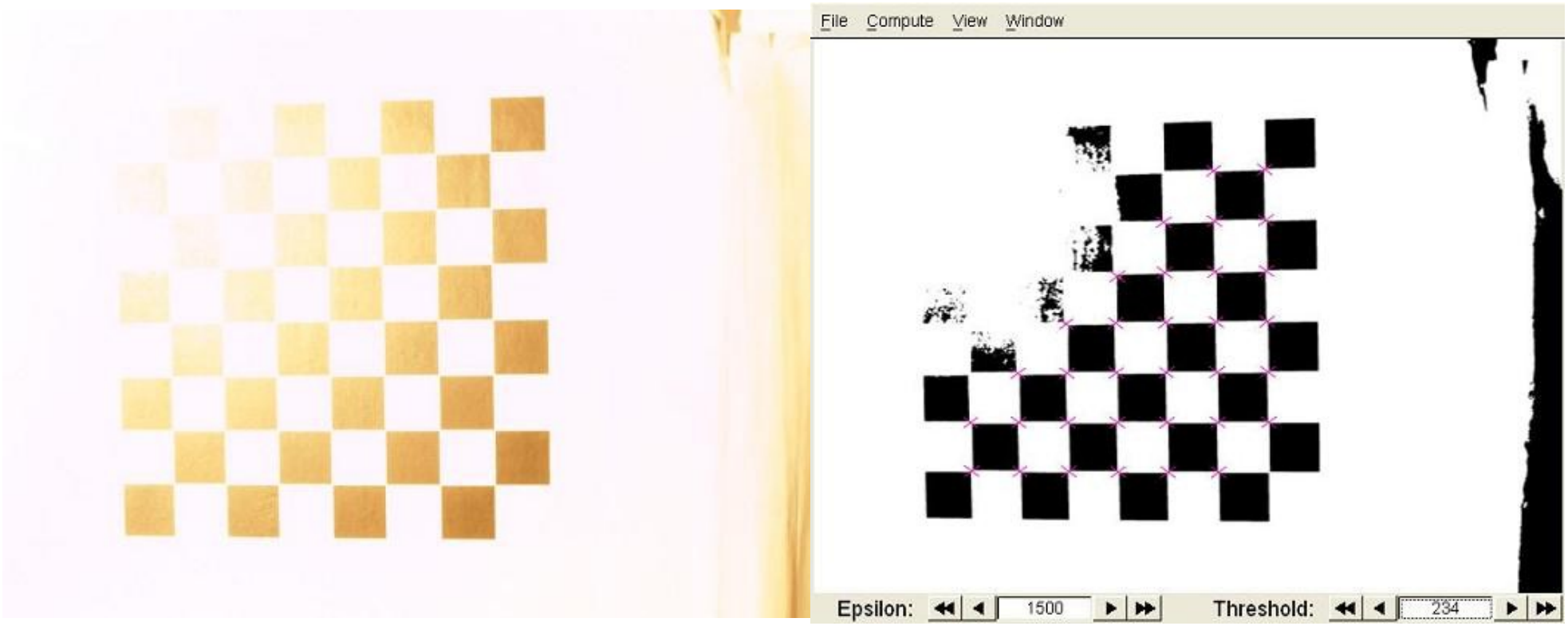
Depth of Field

D(N): near distance
s: focus distance
D(F): far distance



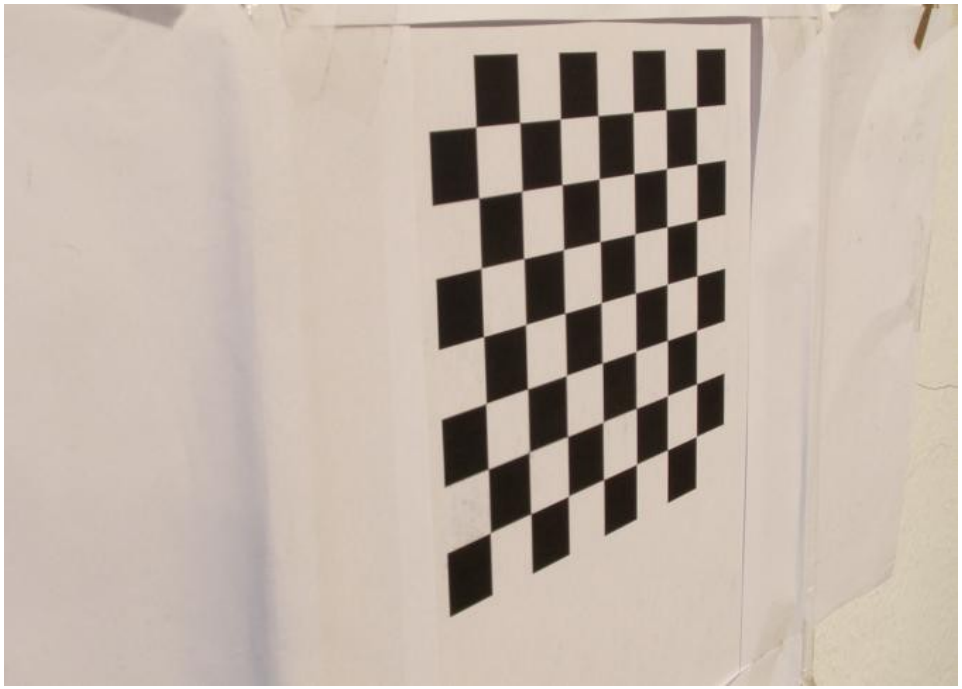
- with smaller lens aperture the sharp area is increased
- we used the smallest lens aperture, because we focused from 121 to 240 without moving the camera
- shutter time was set on one second

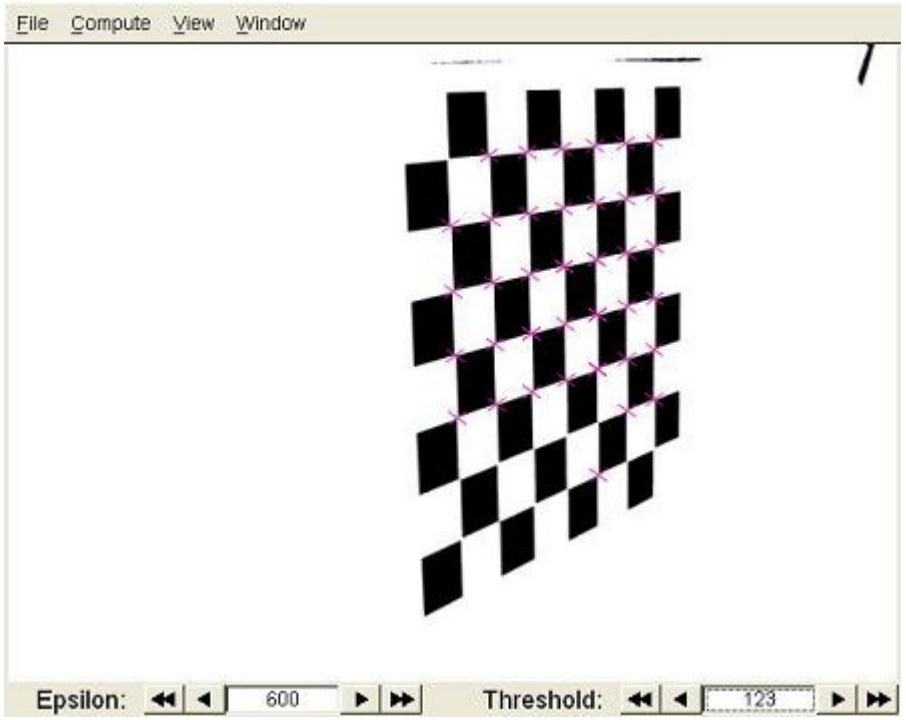
Picture Brightness



important is an uniform illumination of the chessboard, otherwise Cam Checker can't find all points

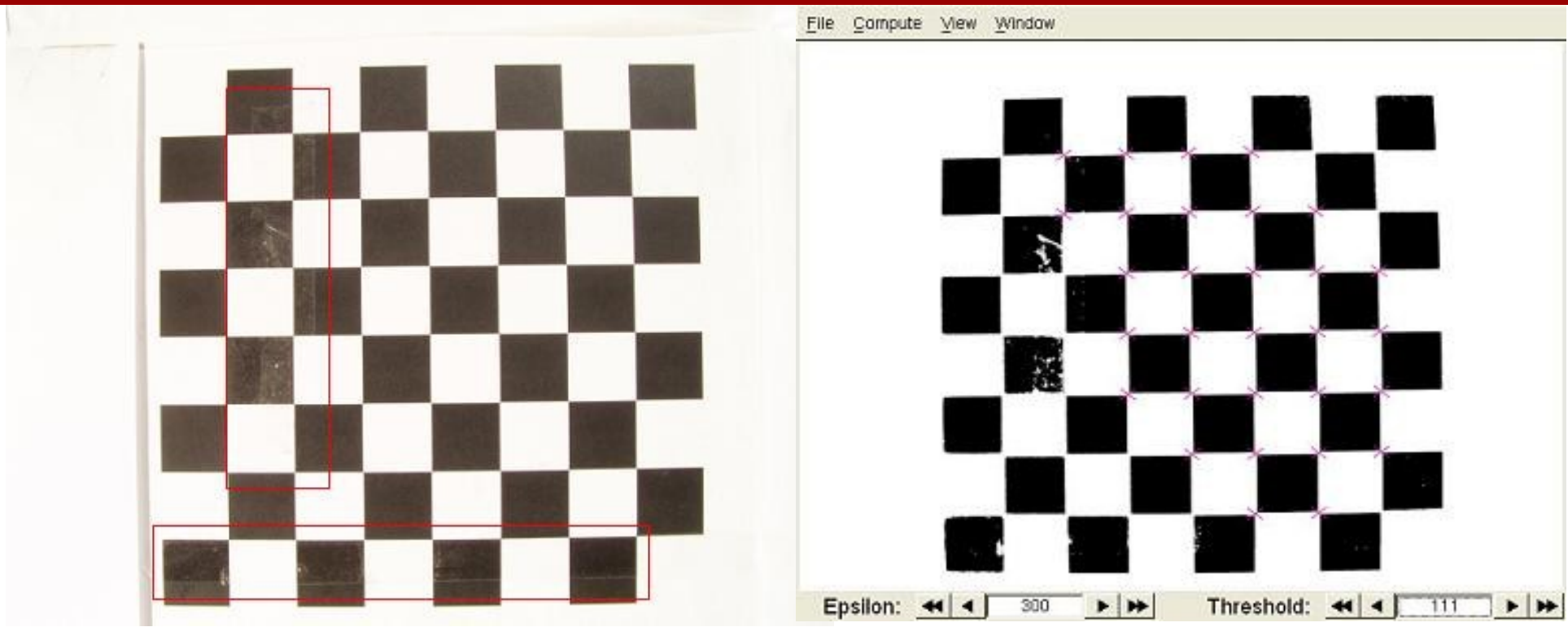
Capturing Angle





- with an angle too large, Cam Checker can't find all points
- we varied the angle from 0° to ca. 30°

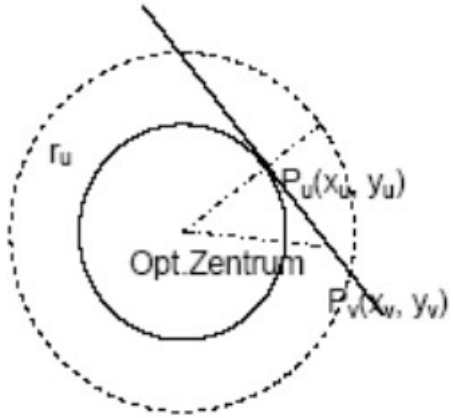
Reflective Materials



- reflective materials on the pictures can cause errors, because the brightness is no longer uniform
- no use of reflective paper for the chessboard
- carefull use of glue strips

Types of Distortion

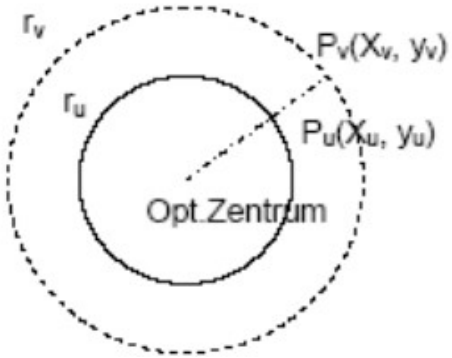
- two types of distortion exist in photography:
  - tangential
  - radial
- Tsai and Zhang wrote both in their papers, that the tangential distortion can be disregarded
- tangential distortion means a shift of a pixel along the tangent



tangential distortion

Types of Distortion

- as Zhang and Tasi wrote, radial distortion is the important factor in photography
- radial distortion is an shift of an pixel along the radius
- radial distortion is raising with distance to the optical center

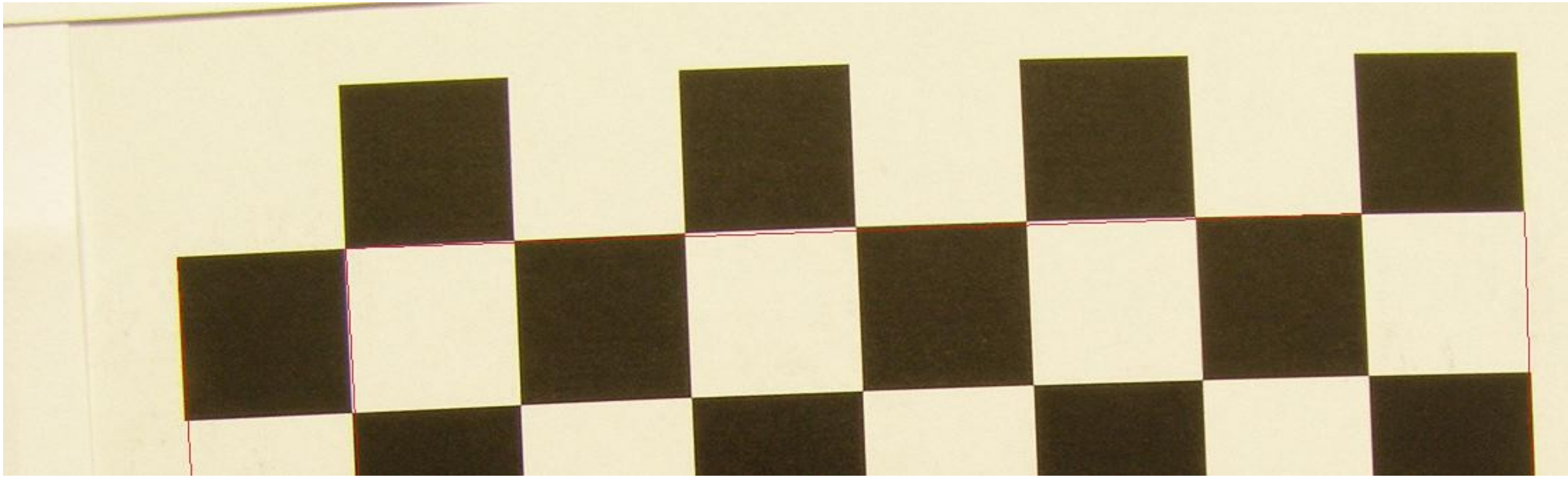


radial distortion

Deskew

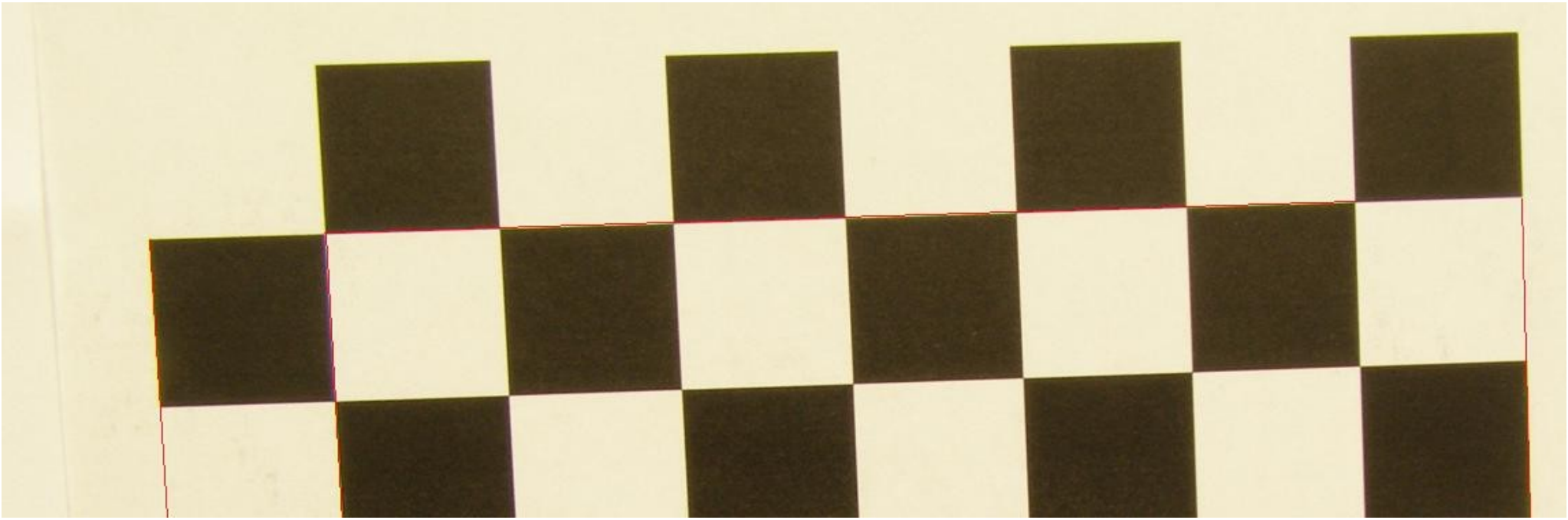
- with these basics we started to get intrinsics and deskew pictures
- the pictures were made with the lowest zoom (63)
- in the following we see the outcomes

Deskew



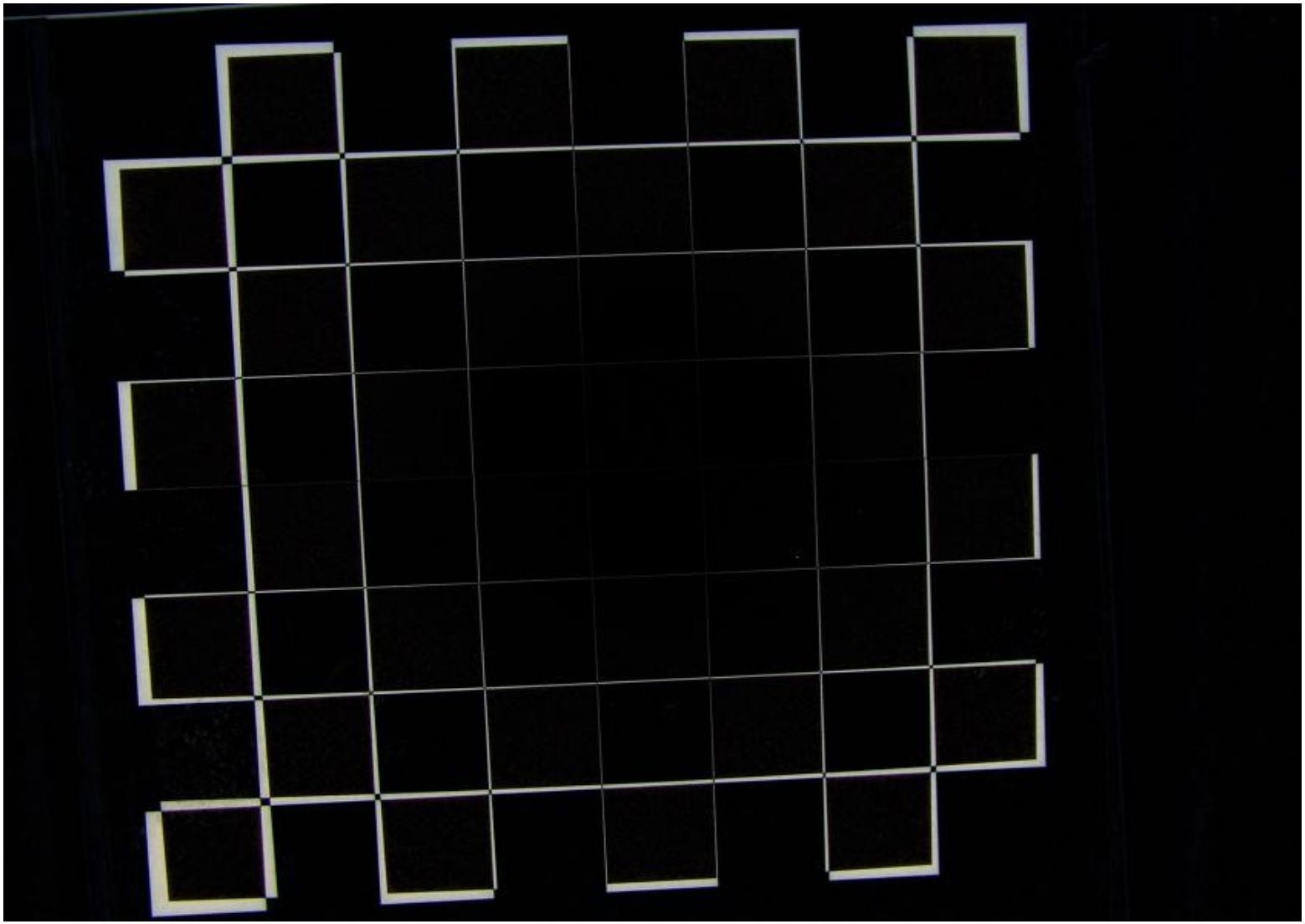
- original picture with distortion
- red line is not even to the squares

Deskew



- picture deskewed with intrinsic parameters, calculated with Cam Checker
- red line is now even on the squares

Deskew

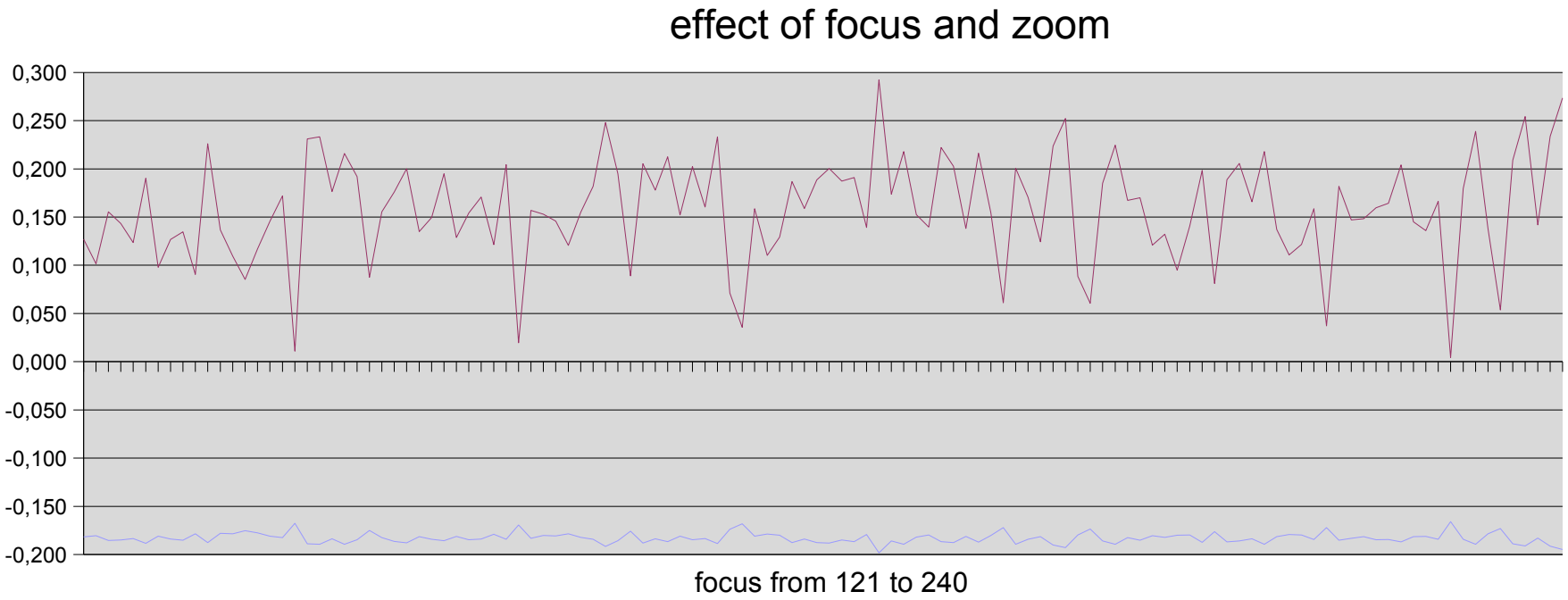


difference between original and deskewd picture

Problem

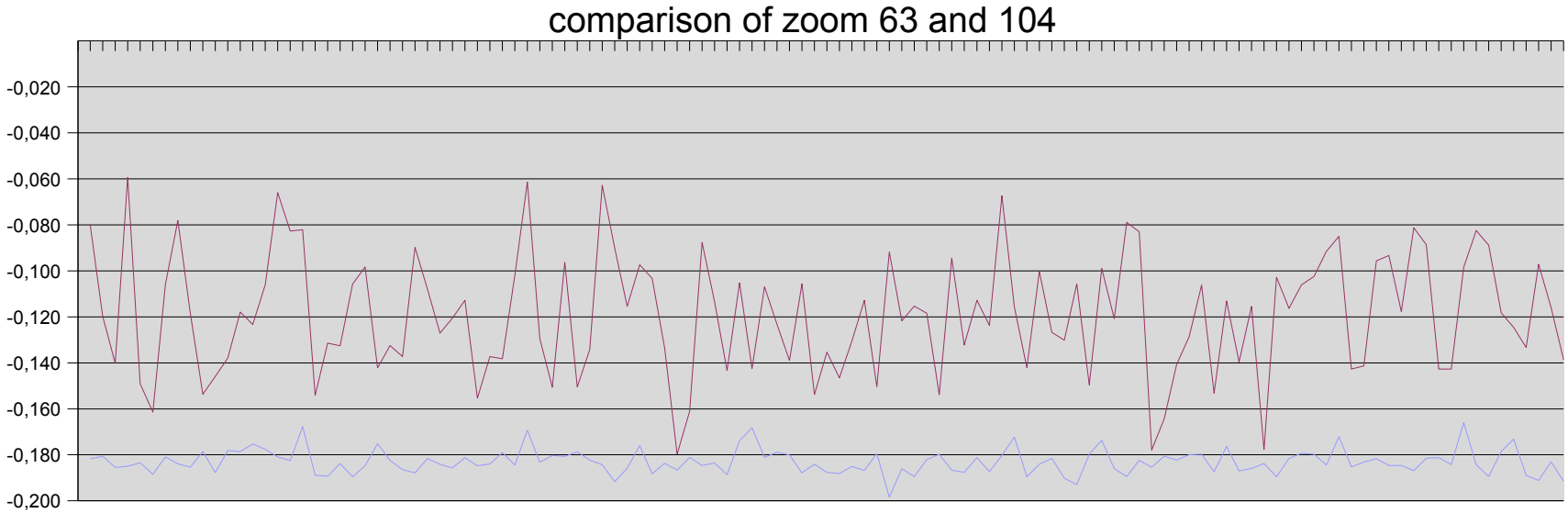
- one big problem of the calibration is the massive time and disc space requirement
- for each combination of zoom and focus we need 10 pictures
- 62400 pictures have to be made
- circa 200 gigabyte disc space is necessary
- ca. 400 hours to make all pictures and analyze them with Cam Checker
- so we need to reduce the data, without losing much accuracy

Evaluation



- graphic shows the distortion over the focus with zoom 63
- there is no tendency over the focus
- blue line is k0 (first part of polynom) and red line is k1 (second part of polynom)
- k0 has more influence then k1

Evaluation

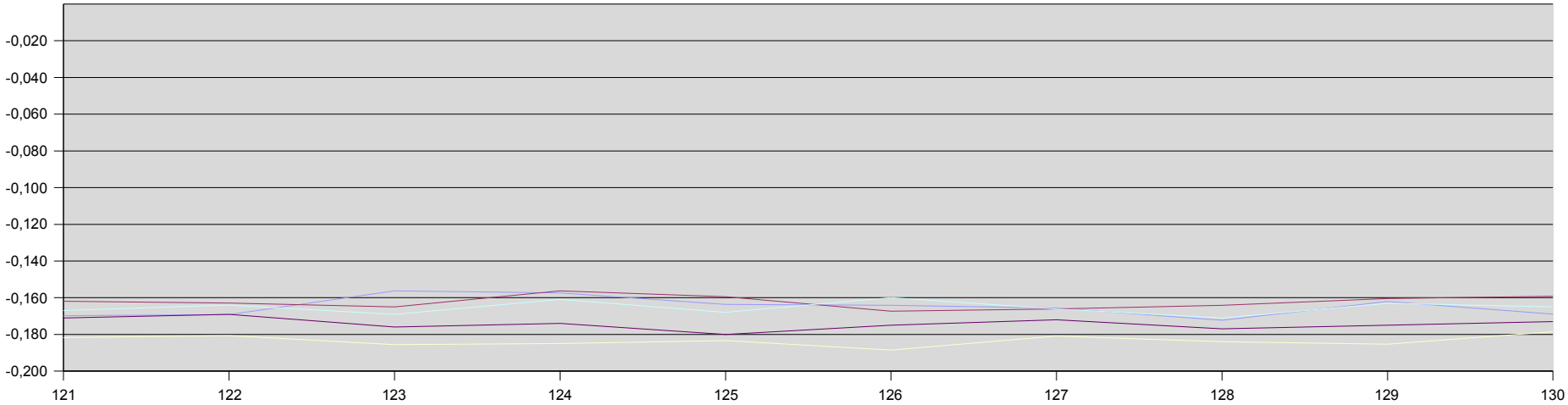


- zoom has big influence on the distortion
- with higher zoom, the standard deviation is rising
- so we need data for the complete range of zoom
- for focus it is enough to take an average

Evaluation

- how stable are the outcomes from Cam Checker?
- we took several times pictures for zoom 63 and focus from range 121 to 130
- the setting was not modified
- only the angles were not exact the sames

Evaluation



- every time we take new pictures for the same zoom and focus settings, we get intrinsics, which are in the same range
- but there is still an error of 10%

Conclusion

- we found that changing zoom has influence on the intrinsic parameters
- changing focus has no visible influence on the intrinsics
  - the values change, but with no system
  - when new pictures are made, the values are changed
  - but the average over the focus is relative stable (10% discrepancy)
- so it should be enough, just to take every fourth or fifth focus, to reduce the data to 20-25%

Literature

1) Zhengyou Zhang.
Flexible Camera Calibratin By Viewing a Plane Fram Unknown Orientations. Technical report, Microsoft Research, 1999.
2) Roger Y. Tsai.
A Versatile Camera Calibration Technique for High-Accuracy 3D Machine Vision Metrology Using Off-the-Shelf TV Cameras and Lenses. IEEE Journal of Robotics and Automation, 1987.
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4) www.wikipedia.org
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