CMSC733: Homework 1 - AutoCalib

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I. Introduction

The goal of this assignment is to calibrate the camera using the method purposed by Zhengyou Zhang of Microsoft[1]. The process of camera calibration estimates the parameters such as focal length, distortion coefficients and principle point. However, there may be radial distortion in the image when the camera lens is in non-ideal situation. Thus, we assume that the radial distortion exists.

II. Data

The checkboard pattern we are given has the square size of 21.5 mm and has 6 rows and 9 columns.

III. Implementation Details

A. Initial Parameter Estimation

1) Approximate camera intrinsic matrix K:
For each input image, I use the OpenCV function findChessboardCorners() to obtain the chessboard corners. The corners are row by row, left to rigth in every row. Furthermore, the OpenCV function cornerSubPix is introduced to get the accurate corner locations. As for world points, a mesh grid is created depending on the number of rows and columns of the checkboard and is multiplied by the square size. Therefore, we can estimate homography between the world points and the corresponding corner points for each image. Then, from Section 3.1 in [1], we learn that we can get the camera intrinsic matrix from the homography matrix we get.

2) Approximate camera extrinsics R and t:
From Section 3.1 in [1], we also acknowledge that we can get the camera extrinsics after we obtain the homography matrix and the camera intrinscs

3) Approximate Distortion k_c:
The radial distortion parameters k_1 and k_2 are both initialized as 0.

B. Non-linear Geometric Error Minimization

Using the scipy function $optimize.least\_squares$, we can minimize the re-projection error. Moreover, from Section 3.3 in [1], we can establish the loss function.

C. Results and Conclusion

After the optimization, the reprojection error is 0.7471491608110673. Also, the camera matrix obtained is:

$$K = \begin{bmatrix} 2075.6 & -3.76 & 756.3 \\ 0 & 2064.9 & 1361.3 \\ 0 & 0 & 1 \end{bmatrix}$$

$$k_c = \begin{bmatrix} -4.327e-05 & -4.54e-04 \end{bmatrix}$$

Overall, this assignment help us to gain the understanding with the camera calibration process that proposed by Zhang.

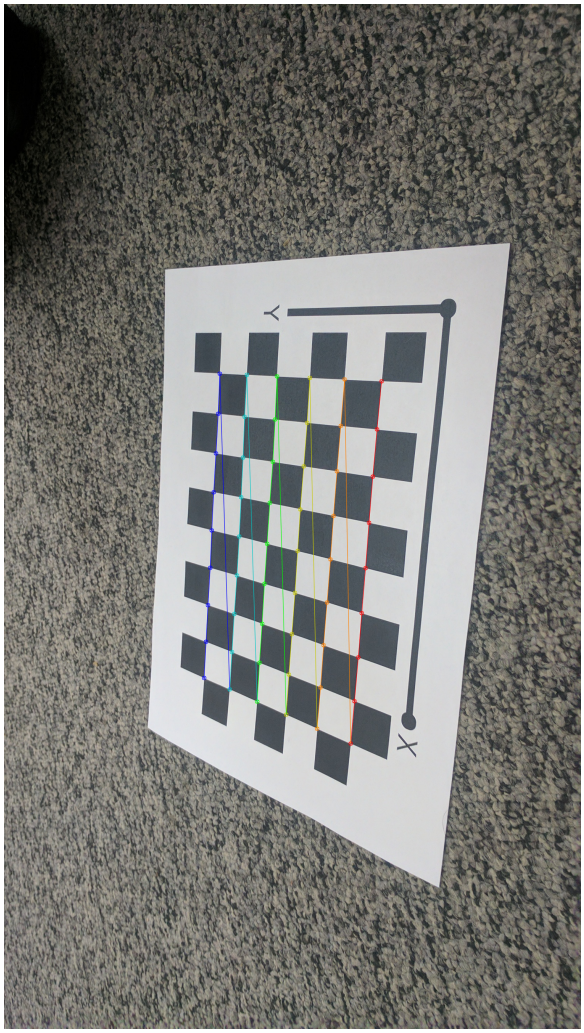

Fig. 1. Displaying the chessboard corners

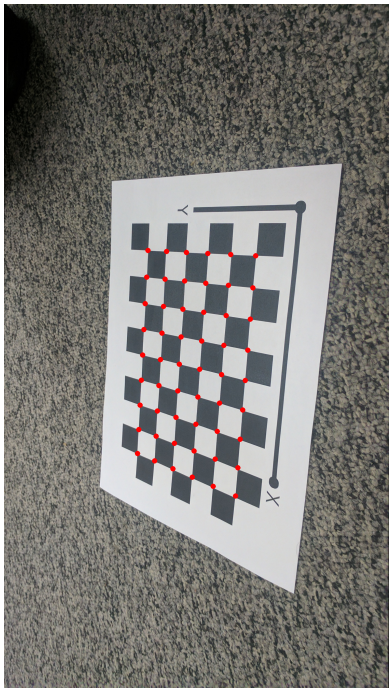

Fig. 2. Reproject the corners on the rectified image

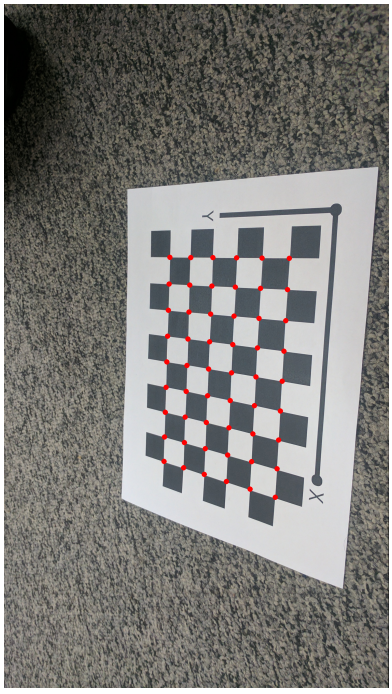

Fig. 3. Reproject the corners on the rectified image

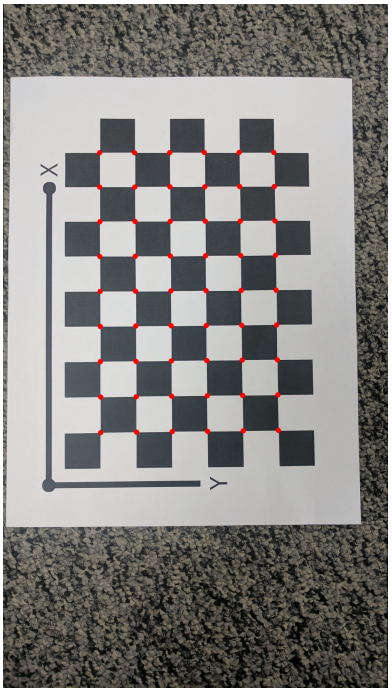

Fig. 4. Reproject the corners on the rectified image

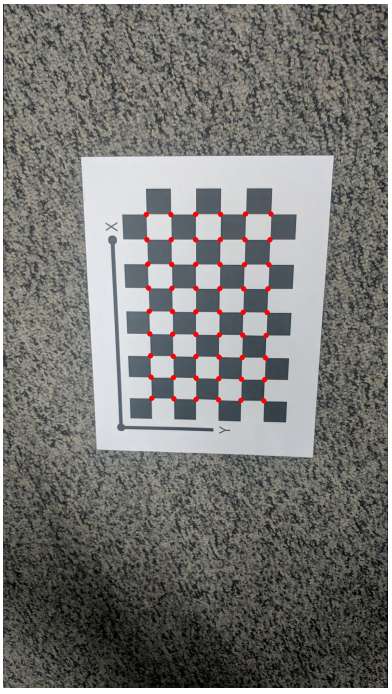

Fig. 5. Reproject the corners on the rectified image

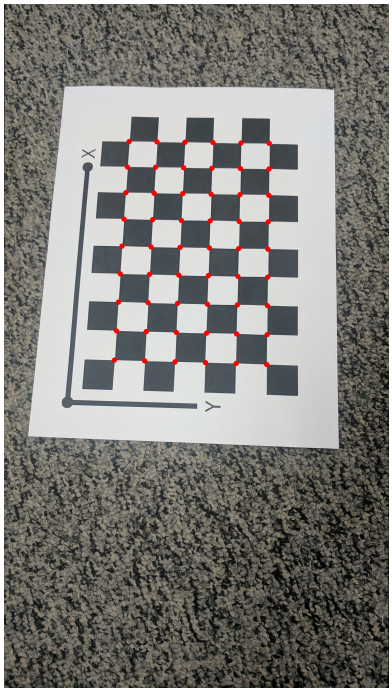

Fig. 6. Reproject the corners on the rectified image

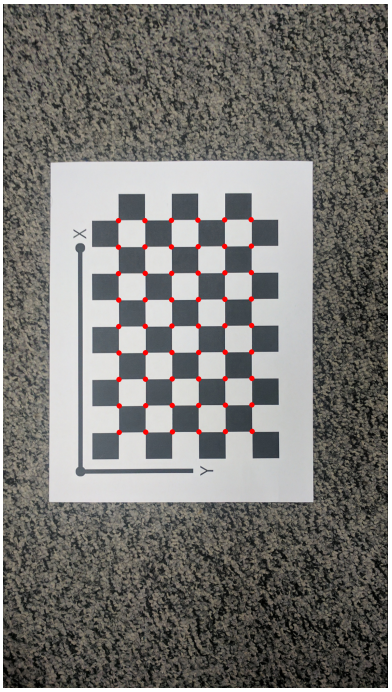

Fig. 8. Reproject the corners on the rectified image

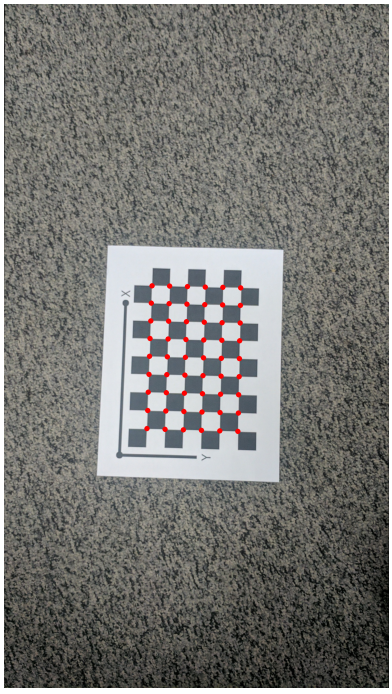

Fig. 7. Reproject the corners on the rectified image

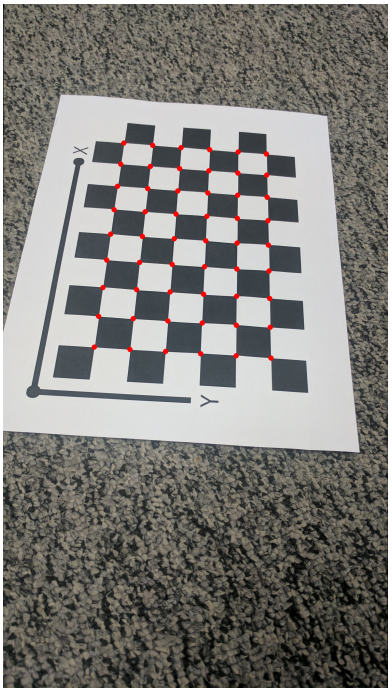

Fig. 9. Reproject the corners on the rectified image

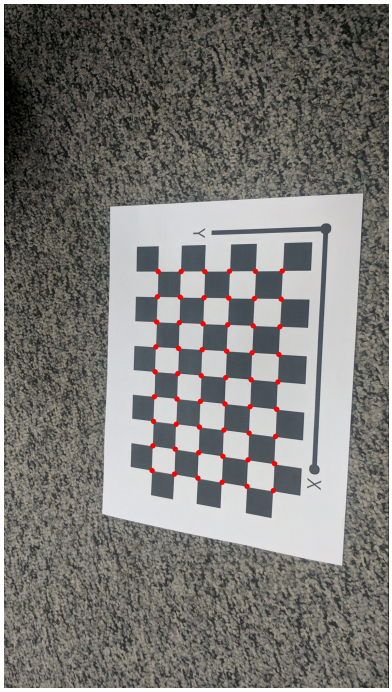

Fig. 10. Reproject the corners on the rectified image

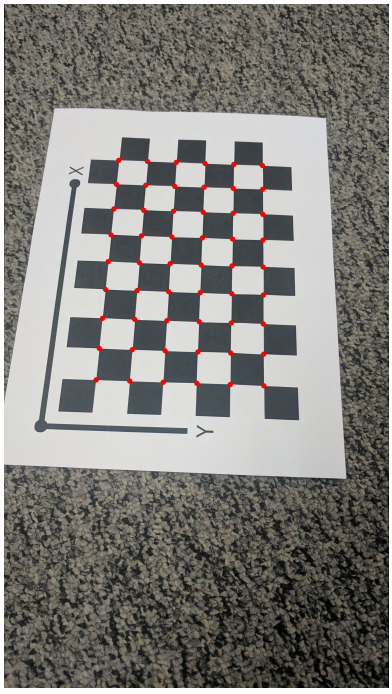

Fig. 11. Reproject the corners on the rectified image

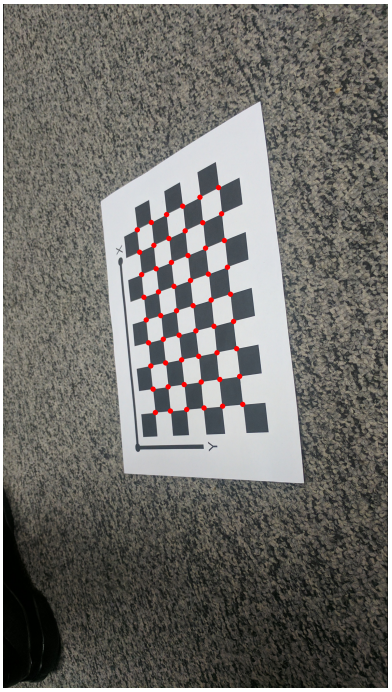

Fig. 12. Reproject the corners on the rectified image

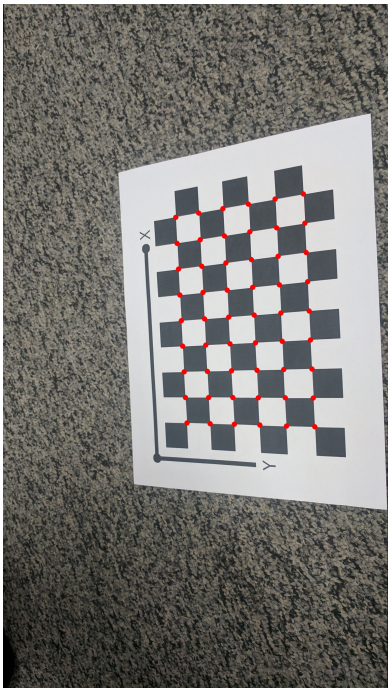

Fig. 13. Reproject the corners on the rectified image

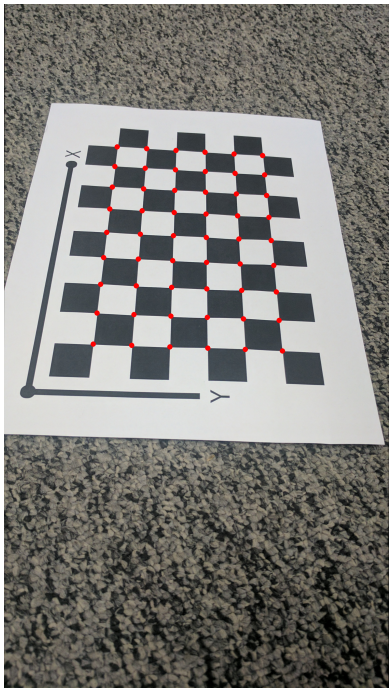

Fig. 14. Reproject the corners on the rectified image

REFERENCES

[1] Zhengyou Zhang (1998)
A Flexible New Technique for Camera Calibration