CMSC733 - Homework 1

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I. Introduction

This homework deals with estimating the parameters of a camera, i.e., focal lengths, distortion coefficients and principle point from a provided set of images of a chessboard pattern taken using the camera from different angles. The method used in this project is called 'Zhang's camera calibration.' The next section discusses, in brief, the steps taken to calibrate the camera and estimate its parameters. And the section after that shows the results of calibration process by re-projecting the calculated points on top of the captured images.

II. Procedure

The following process was followed to estimate the camera coefficients:

- First we estimate initial guesses for the intrinsic parameters of the camera as described in the section 3.1 of [1]. To estimate the intrinsics, we calculate the real world points on the chessboard using a simple meshgrid function with the hand measured size of the square on the chessboard.
- Then, we estimate the extrinsic parameters from the estimated intrinsic parameters also as described in section 3.1 of [1].
- Next, we assume the initial guesses for the distortion coefficients to be 0 and let them be automatically estimated in the next step.
- Next, we optimize the initial guesses of intrinsics, extrinsics and distortion coefficients by setting up a maximum likelihood estimation problem that minimizes the geometric error between the actual detected corner in the chessboard and the corner estimated from the camera parameters. The loss function used to perform this optimization is written as described in [2].
- The obtained final results for intrinsics, extrinsics and distortion coefficients are then used to re-project the originally detected points back onto the chessboard images and calculate the final re-projection error.
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III. Results

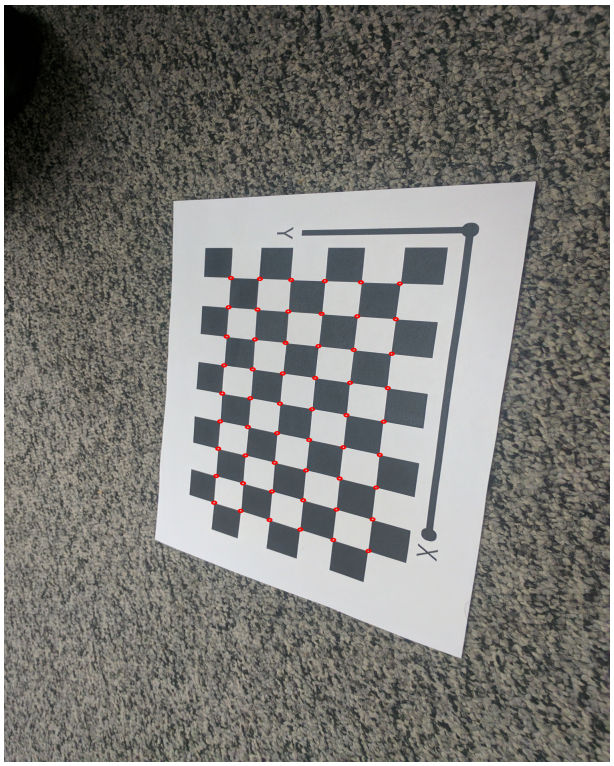
The obtained final camera matrix is as follows:

$$\begin{pmatrix} 2.05e3 & -1.12 & 7.61e2 \\ 0 & 2.04e3 & 1.35e3 \\ 0 & 0 & 1 \end{pmatrix} \tag{1}$$

The re-projection error before optimization was 0.69 and was reduced to 0.67 after optimization. The results of re-projecting the points on the chessboard images can be seen below.

IV. References

- [1] Microsoft paper provided
- [2] Book on camera calibration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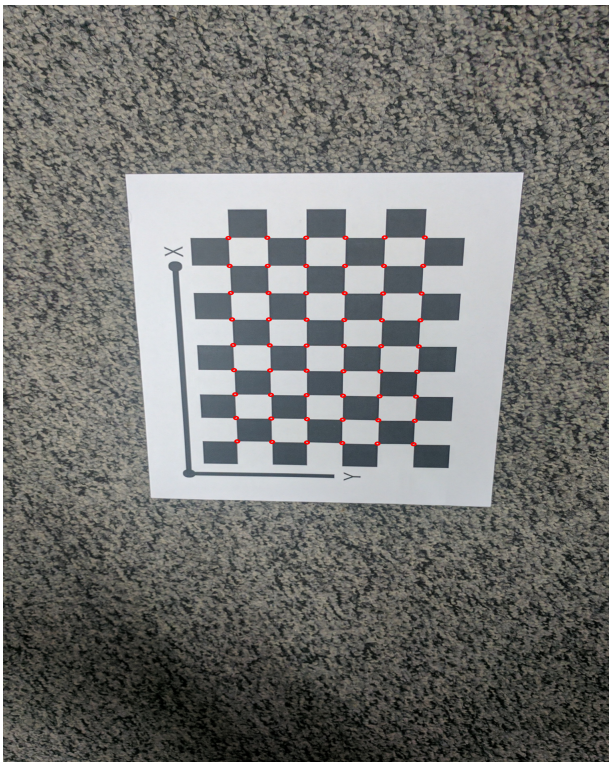
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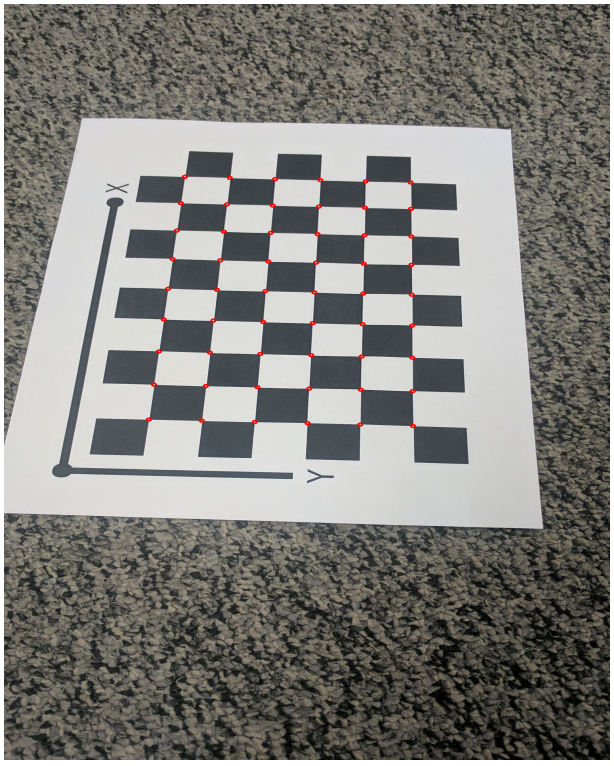
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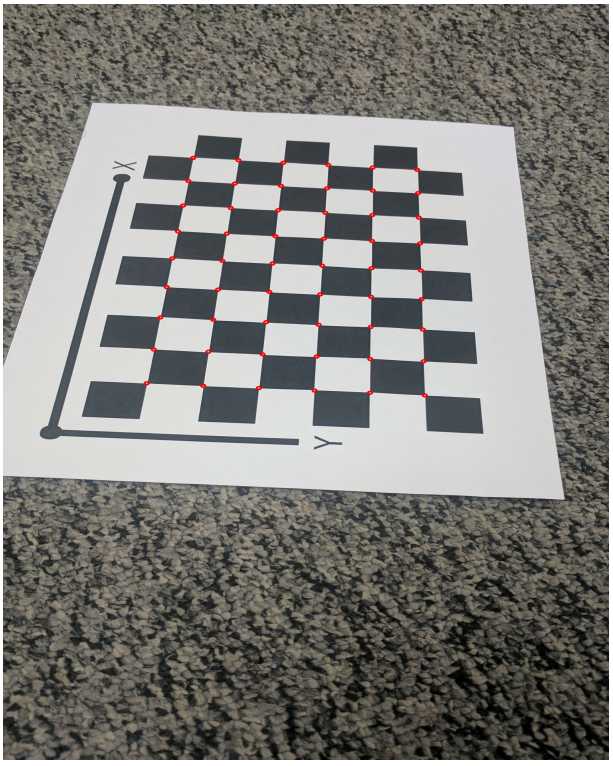
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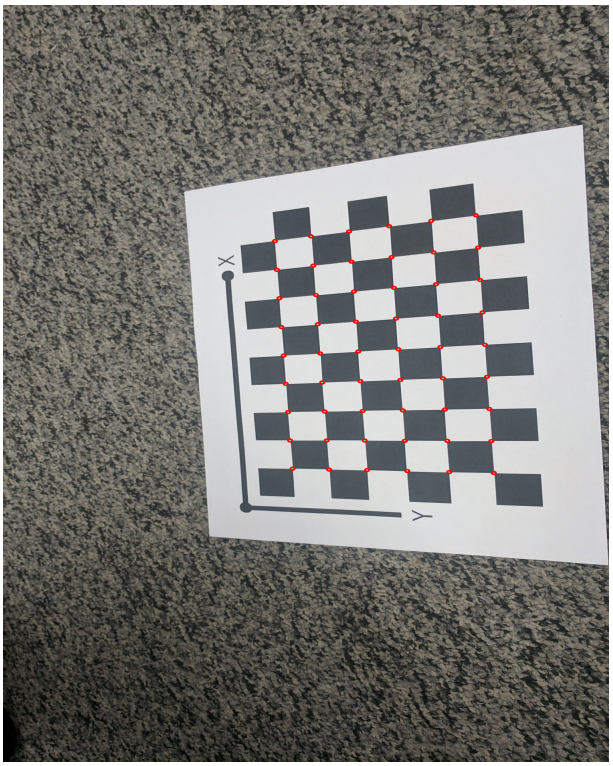
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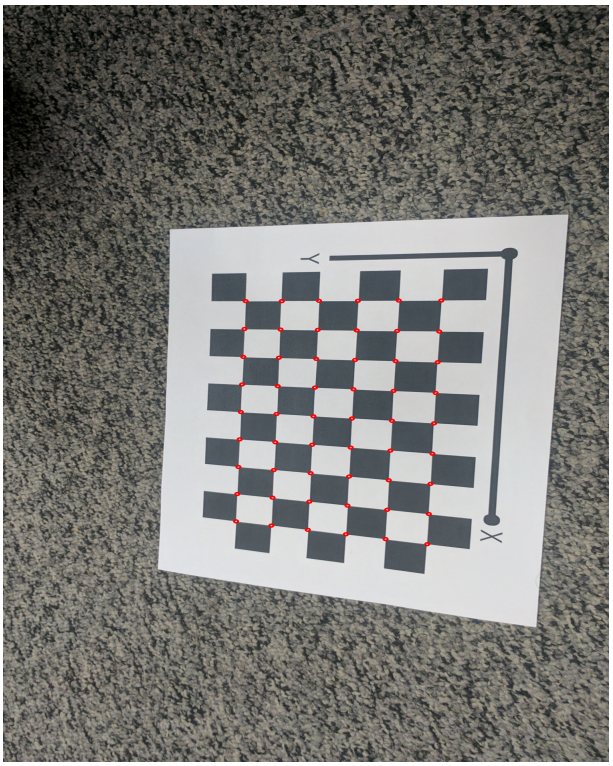
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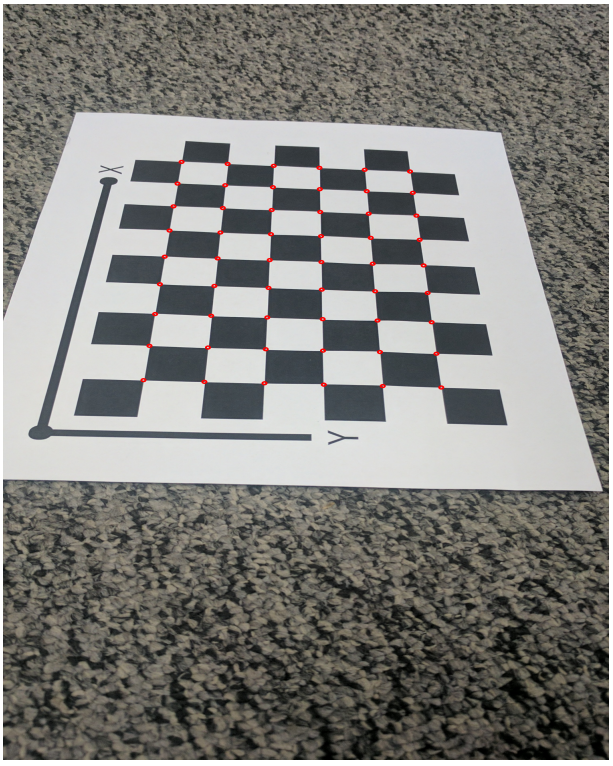
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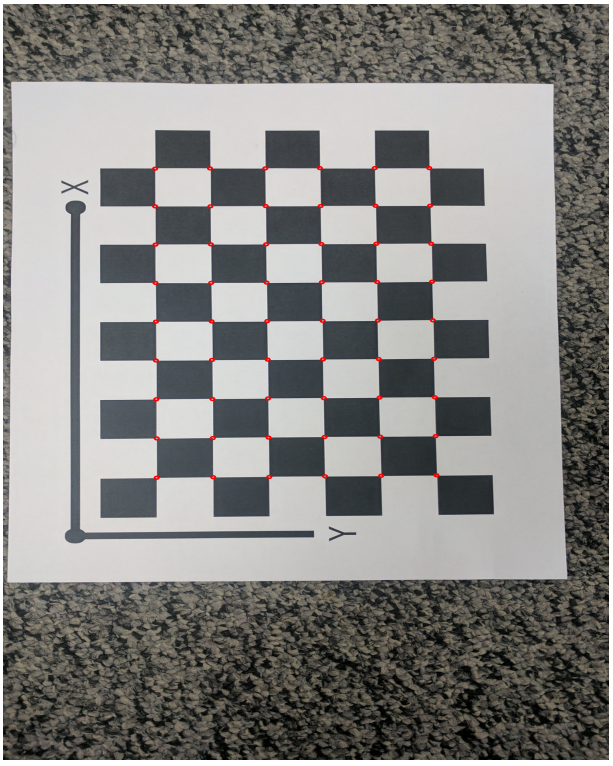
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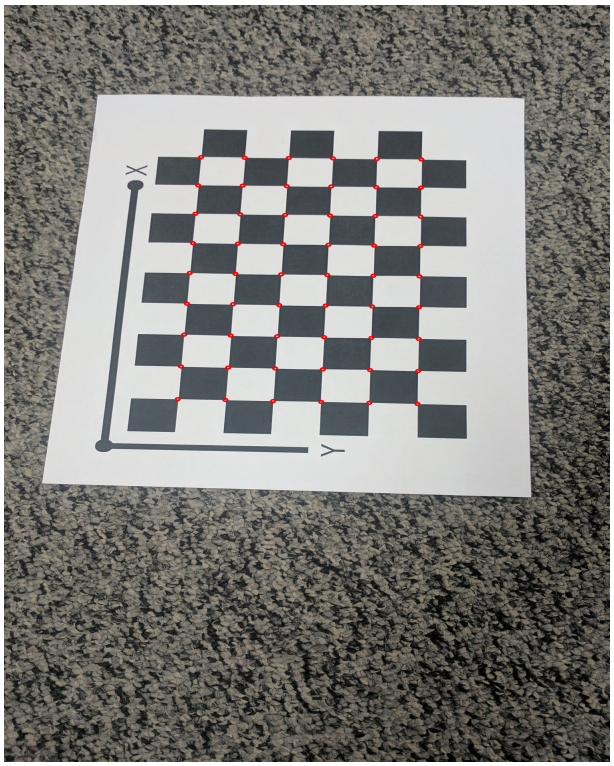
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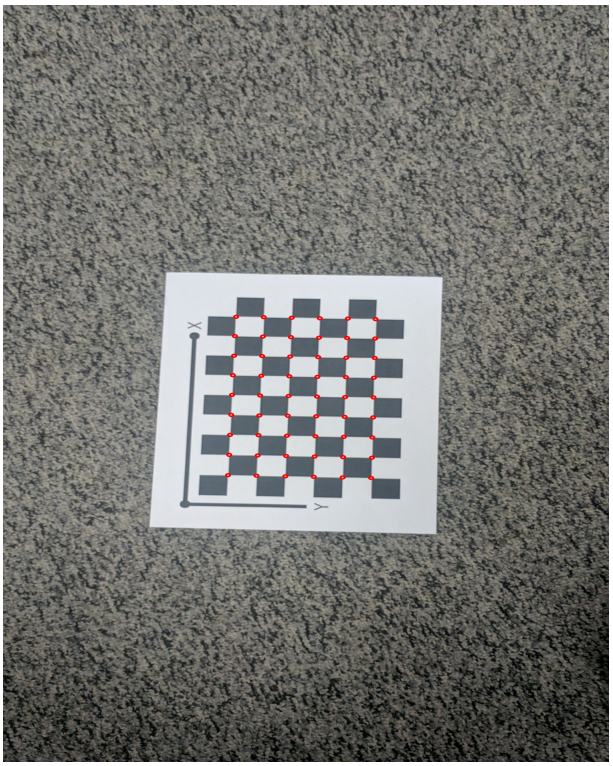
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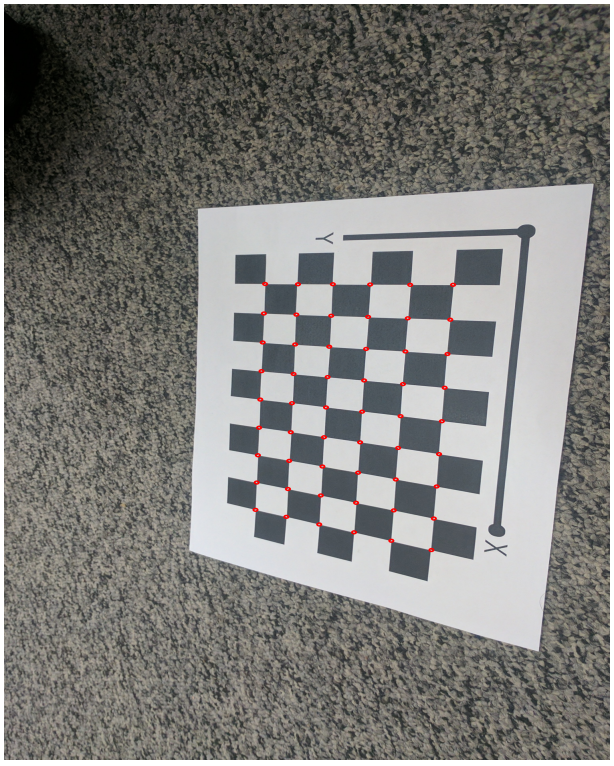
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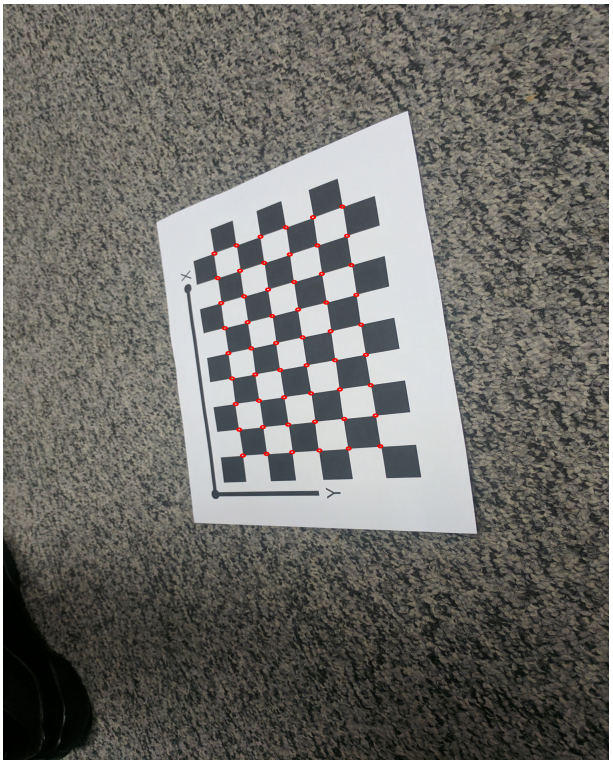
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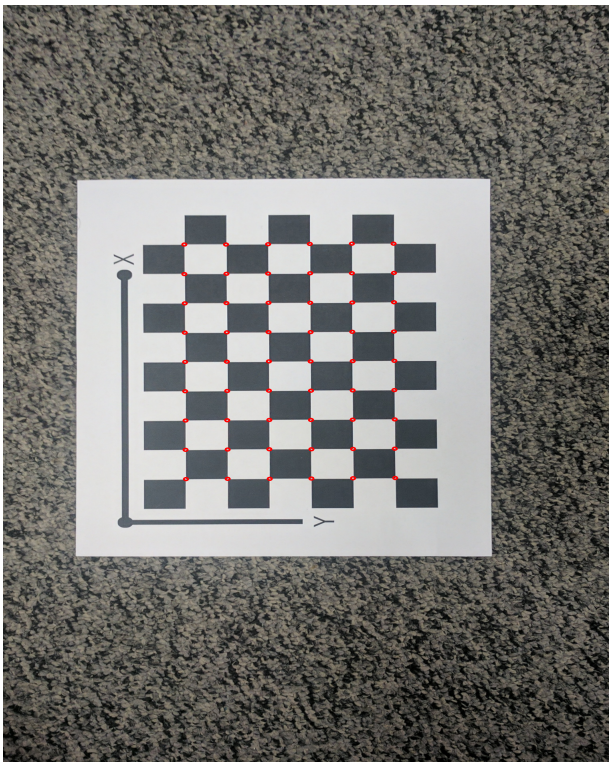
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