Robot vision - assignment2

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task 1

task 1a

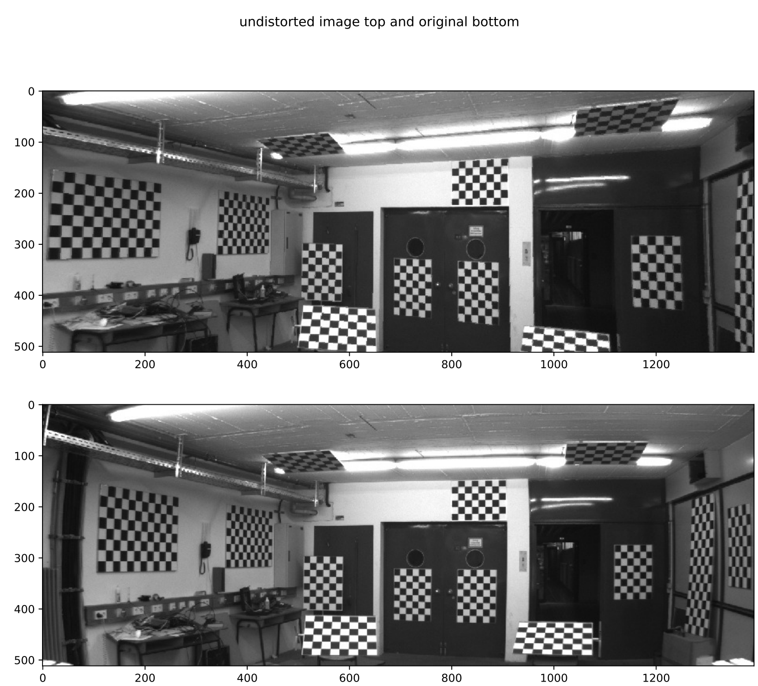

Figure 1: Undistorted image

We see that the outlines of the original image are now gone. This makes sense as to undistort you have to "bend out" the radially distorted parts resulting in a stretch of the image in some sections

task 1b

You convert back to world coordinates using the intrinsic parameters of the camera which took the picture. You then convert to pixels using OTHER intrinsic parameters than the ones you used earlier.

task 1c

we have the pinhole camera equations
u = c$_x + f_x \frac{X}{Z}$
$v = c_y + f_y \frac{Y}{Z}$
$u = c_x + f_x(x + \delta_x)$
$v = c_y + f_y(y + \delta_y)$ Using the tangential distortion coefficients we can change the orientation of the image by giving false tangential distortion coefficients, compensate for this and then project onto the image plane.

1d

This would involve us knowing the distance to every single object that is included in the picture. A single lens camera suffers from not being able to estimate the size of different objects because of the way it takes in light in a conical manner. If we were to virtually move the camera to a different position we would have to know either the distance to all the objects from the original position or the size of the objects which we do not. We can however see the image at a different position if the image is planar or sufficiently far away from the camera.

Task 2

2a

The intrinsics of the camera model in figure 1 are the focal lengths fx and fy, the principal point (cx,cy) and the distortion coefficients. The extrinsics are the parameters describing the rotation and translation from world frame to camera frame. This could include up to 3 angles and 3 translations so there is 6 extrinsic parameters in total.

2b

The advantages of using a planar calibration target is that the target is flat and we have to do no compensation in postprocessing. It is just easier to determine the parameters while operating on a planar target with known distances and size.

2c

One could experience some light diffraction of the image when showing it on a screen if there is a tangential distortion present between the image and the camera. This is because it has to pass through the screen. This does not occur if we have a printed image as the only lens between the camera and the image is the camera lens.

2d

We have 11 unknowns so we need at least roof(11/2) = 6 equations to determine the intrinsics and extrinsics. For each correspondence we get two equations so we need 6 correspondences to get 6 equations. The correspondences need to exist in 3D-space or our set of equations becomes rank deficient

2e

The image is only in 2 dimensions which means it cannot be used alone to uniquely determine all the camera matrix parameters. Looking at

$$\begin{pmatrix} X_1 & Y_1 & Z_1 & 1 & 0 & 0 & 0 & 0 & -u_1X_1 & -u_1Y_1 & -u_1Z_1 \\ 0 & 0 & 0 & 0 & X_1 & Y_1 & Z_1 & 1 & -v_1X_1 & -v_1Y_1 & -v_1Z_1 \\ & & & & & \vdots & & & & & \\ X_N & Y_N & Z_N & 1 & 0 & 0 & 0 & 0 & -u_NX_N & -u_NY_N & -u_NZ_N \\ 0 & 0 & 0 & 0 & X_N & Y_N & Z_N & 1 & -v_NX_N & -v_NY_N & -v_NZ_N \end{pmatrix} \begin{pmatrix} C_{11} \\ C_{12} \\ \vdots \\ C_{33} \end{pmatrix} = \begin{pmatrix} u_1 \\ v_1 \\ \vdots \\ u_N \\ v_N \end{pmatrix} \qquad \text{(11.1}$$

Figure 2: Camera equations

we see that for a coplanar calibration image we get infinitely many combinations of one variable as all elements in the columns containing Z can be eliminated against each other

2f

If we have the same calibration errors in the calibration image and the image being reprojected we can have zero reprojection error, but bad calibration.