Assignment 1

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1 DESCRIPTION

The goal of the assignment is to familiarize you to the process of camera calibration and the critical role it plays in using any measurements of the world from images.

2 DIRECT LINEAR TRANSFORM

2.1 CAMERA CALIBRATION

We manually calculated, image points and world points. From which we calculated projection matrix, camera matrix, rotation matrix For camera matrix,

$$X_c = \mathrm{P}^* X_w$$

where X_c is image coordinates
P is the camera matrix
X_w is world coordinate

For rotation matrix and centre of projection,

$$X_c = \mathrm{K}[\mathrm{R}|\mathrm{C}]^* X_w$$

where X_c is image coordinates
K is the camera matrix
R is the rotation matrix
C is the projection centre
X_w is world coordinate

2.2 Camera Calibration using RANSAC

In this we have to perform the above calibration procedure using RANSAC (Random Consensus Sampling).

Algorithm 1: RANSAC Algorithm

1.) Random sampling of MSS (Minimal Sample Set)
2.) Estimation of fundamental matrix with MSS (SVD)
3.) Evaluation of norm of error
4.) Evaluation of no. of inliers
5.) Routine iterated for k random samples
6.) Matrix with greatest no. of inliers chosen

2.3 Radial Distortion Correction

Given an image we have to correct the radial distorton in it.
1.) Divide the given pixel points in 2 parts (x1,y1),(x2,y2),...(xn,yn) and (x'1,y'1),(x'2,y'2),.....(x'n,y'n).
2.) Now matrix A = {(x1/x'1 -1),(y1/y'1 -1), (x2/x'2-1).....}
3.) Matrix b = {(r1,$r1^2$),(r2,$r2^2$),.....(rn,rn^2)}
where r1 = $\sqrt{}$x1^2 + $y1^2$
r2 = $\sqrt{}$x2^2 + $y2^2$
and so on

$$AX = b$$
Decompose A into QR decomposition
$$QRX = b$$
Multiply both sides by Q^T
$$Q^T QRX = Q^T b$$
$$RX = Q^T b$$
$$X = R^-1 Q^T b$$

4.) Apply the function cv2.undistort() to get the required undistorted image.

3 Zhang Method

1.) We are given a set of images and we have to perform camera calibration using Zhang method.
2.) After performing camera calibration, we have to wireframe the given images.
3.) We cannot get the world points from the pixel points and calibration matrix as we need projection matrix for it and projection matrix is given by:

$$P = K[R|C]$$
p = Projection matrix
K = calibration matrix
R = Rotation matrix

C = projection centre

4 HANDS ON

1.) In this we click images from our phone. And perform the experiments performed above using our images.
2.) Change in focal length will lead to change in projection matrix.

5 RESULTS

1.) Jupyter notebook and the images folders are attached in the file.