Course: CS55700

Name: Weijian Zheng

Project 1 Report

Camera Calibration

Background and introduction

For pinhole camera model, we need projection parameters to model the image formation process. By applying those parameters to a 3-D object, we can compute the 2-D coordinates of it in the image plane.

There are two kinds of the projection parameters. One is called extrinsic parameters. Extrinsic parameters are majorly used to measure the initial position of the camera. More specifically, we use the rotation matrix R to translation matrix T. Another kind of parameters are called intrinsic parameters. Intrinsic parameters are used to measure the internal parameters of camera itself. It includes focal length, image center and scale factors. The accurate estimate of the parameters above is required for many other applications in compute vision. That procedure is called camera calibration.

Algorithms and steps

There are many different kinds of calibration methods. For our project, we have two major steps. In the first step, we will compute the 3-by-4 projection matrix *P* using 6 given points’ both 2-D and 3-D coordinates. Then, we will normalize the projection matrix *p* and recover the intrinsic and extrinsic. In the following part, the more detail of each step will be presented.

1. For camera calibration, we will firstly build a 12-by-12 matrix *B* includes all the coordinates of our 6 collected points. Its form is as follows:

We can see that each points contribute two rows of this matrix B.

1. After building matrix B, we will use SVD to infer the projection matrix. More specifically, if we have , the elements of projection matrix P is coming from the last column of matrix H.
2. After reshape, we have a projection matrix P in this step. We will firstly normalize this matrix using the. After that, we will rename is left three columns of matrix P as L and right one column as R.
3. In this step, we will firstly compute the as matrix A to recover the matrix. Before next step’s recover of parameters. In this step, we need to normalize the matrix A by.
4. Then, in this step, we can recover all parameters using normalized matrix A.
5. In the last step, we will use our computed parameters to test some points. Also, the distance between our predicted 2-D coordinates and actual 2-D coordinates will be computed.

Results:

In this project, we assume there is no skew for our calibrated camera. Thus, I have the following predicted parameters.

Verification:

References:

[1] Remondino, Fabio, and Clive Fraser. "Digital camera calibration methods: considerations and comparisons." International Archives of Photogrammetry, Remote Sensing and Spatial Information Sciences 36.5 (2006): 266-272.