Calculate depth from disparity by using SVD

1. Fundamental Matrix estimation

After getting the coordination of 2-d feature keypoints,we use this data to calculate the fundamental matrix by using 8 points method.

1. We have 8 equations and we input exactly 8 points to form the A matrix from them.
2. Then we take the singular value decomposition of the F matrix to solve the homogeneous equation: AX=0.
3. Thus we find the lowest singular value using the last column of the V matrix.
4. Due to noise in the correspondences, the estimated F matrix can be rank 3 so we downgrade the rank of the F matrix.

The fundamental matrix for test dataset is:

[ [ 1.25314032e-06 2.83036938e-06 -1.15636240e-03]

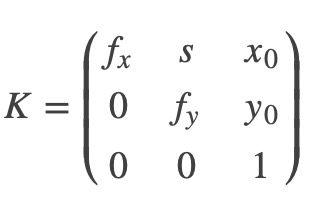
[ 2.02661066e-06 5.19078225e-06 -1.79994023e-03]

[-1.12937801e-03 -2.91944828e-03 1.00000000e+00] ]

B. Estimate camera intrinsic and baselines

Here we load the projection matrices from calib.txt, and use the calibration to calculate the intrinsic matrix and baselines.

1. The intrinsic matrix transforms 3D camera coordinates to 2D homogeneous image coordinates.The intrinsic matrix is parameterized as:



1. The focal length fx,fy is the distance between the pinhole and the film.In a true pinhole camera,both fx and fy have the same value.
2. The “principle point offset” x0,y0 is the location of the principle point relative to the film’s origin.The exact definition depends on which convention is used for the location of the origin.
3. Axis skew s causes shear distortion in the projected image.

The Facal Length for the test dataset is : (718.856, 718.856)

The Image Center for the test dataset is : (607.1928,185.2157)

The Baseline for the test dataset is :0.5371657188644179

C. Estimate Epilines

In this step,we need to calculate the epilines by using the fundamental matrix that we estimated former.

1) Epilines corresponding to the points in first image is drawn on second image.For points in an image of a stereo pair, we using the cv.computeCorrespondEpilines to compute the corresponding epilines in the other image

2) After calculate the Epilines ,we find the closest points on epilines.

The array of distance:

array( [ 758.24896, 764.677 , 753.9035 , ..., 4241.442 , 4641.043 , 4635.4565 ], dtype=float32)

D: Estimate disparity and depth

In this part we compute the disparity by using the Fundamental matrix and estimate the depth.

1) EpipolarLine =np.dot ( F, [ x1 , y1 ,1] )

a,b,c=Epipolarline

Disparity=np.abs(a\*x2 + b\*y2 + c) / np.sqrt(a\*a + b\*b)

1. Using the disparity map from previous step compute the depth information for each

pixel using the below formula:

Depth = (baseline \* focal) / (disparity \* p)

The array of depth:

array( [0.86846906 , 0.87639465, 0.87637367, ..., 1.34276747, 1.44728493,1.48329078] )

E: Compute the rectification transformations

Warp the images to make the epipolar lines horizontal, so that disparity calculation is restricted to one dimension only, this step is to make the camera setups parallel after homography transformation.

1. To rectify the images we use cv2.stereoRectifyUncalibrated() function,and we input the F matrix into this function with feature points and image size.
2. It returns the homography matrices for both the camera H1 and H2.
3. We transform the feature points by multiplying them with the H matrices.
4. In the end we warp both imagines to make the epilines horizontal.

The result of rectification:

