Project-3

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1 Calibration

Following are the steps to calibrate an image using **ORB feature matching**.

1. Converted the image into grayscale.

2. Found matched features between respective images.

3. Segregated only the useful features points based on Lowe's paper.

4. Passed the points to compute Feature matrix using **RANSAC**.

a) RANSAC.

1. Selected random 8 points of both the images.

2. Normalised the points using **Normalisation** process and compute the **F** matrix.

3. Unnormalised the **F** matrix.

4. For all the points in both the images, checked if dstpoints***F***srcpoints.T is less than a certain threshold.

5. Stored the points and the fundamental matrix if the number of points found in the current iteration is greater than previously found.

6. Repeated the above process for fixed number of iterations.

```
Fundamental Matrix :
[[-8.32492178e-33  1.12335335e-18 -1.16113379e-16]
 [-1.05100271e-18  4.23802849e-20 -2.43139908e-03]
 [ 9.58006286e-17  2.39854968e-03  1.48254173e-02]]
```

Figure 1: Fundamental matrix after performing RANSAC

b) Normalisation.

1. Compute the mean of the points.

2. Shift the origin of the points by the mean value.

3. Compute **S** matrix for the points.

4. Compute **T** matrix based on the **S** matrices.

5. Compute nomalised points by multiplying **T** matrix with the original points.

b) Compute Fundamental matrix.

1. Find the **A** matrix based on the values of 8 selected features.

2. Find the SVD of A.

3. Selected the Fundamental matrix as the last column of the **V** matrix

4. if the rank of the **F** matrix is 3, then reduced it by taking its SVD and setting its last element to zero and recomputing the F matrix.

b) Compute Essential matrix, Rotation matrix, Translational matrix.

1. Find the **E** matrix such that **K.T*****F*****K**.

2. Compute 4 possible combinations of **R** and **T** matrices.

3. Selected the Fundamental matrix as the last column of the **V** matrix

```
Essential matrix:
[[ 9.35204572e-27  9.69878491e-12  1.01752853e-12]
 [-1.03080415e-11  1.30723443e-13 -1.25576642e+01]
 [-1.06784935e-12  1.24994503e+01 -4.22455994e-03]]
```

Figure 2: Essential matrix

```
T matrix:
[ 1.00000000e+00  8.13793477e-14 -7.76129161e-13]
```

Figure 3: T matrix

```
R matrix:
[[-0.9998194   0.00339148 -0.0186992 ]
 [-0.00341847 -0.99999316  0.00141178]
 [ 0.01869428 -0.00147545 -0.99982416]]
```

Figure 4: R matrix

2 Rectification

Following are the steps to rectify the images using found **F** matrix.

1. Plot epipolar lines on unrectified images.Computed homography matrices for both the images using cv2.stereoRectifyUncalibrated.

2. Used the homography matrices to warp the images. Changed the Fundamental matrix for the warped images.

3. plot the epipolar lines on the images.

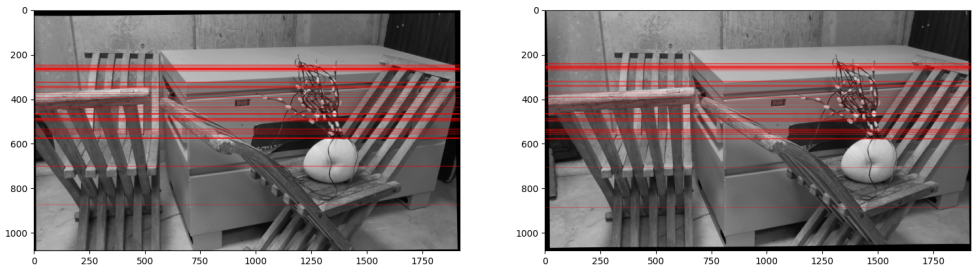

Figure 5: Epipolar lines on unrectified images of Curule

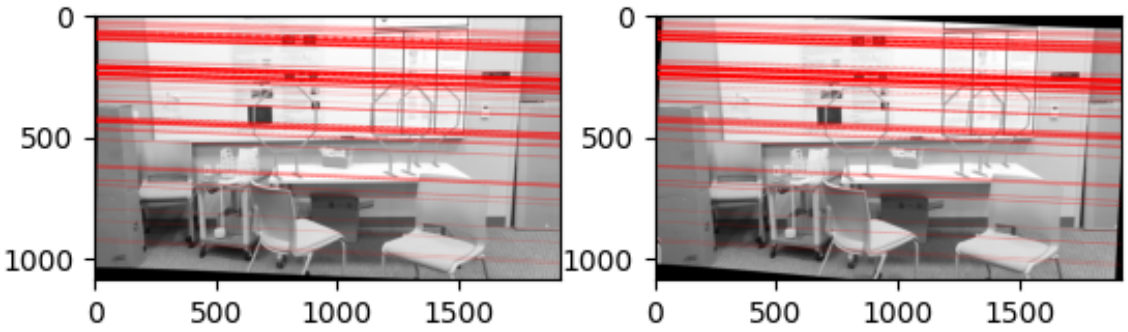

Figure 6: Epipolar lines on unrectified images of Octagon

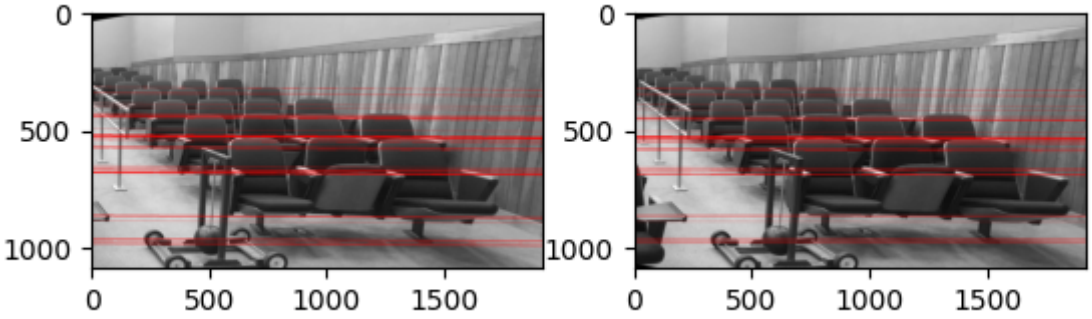

Figure 7: Epipolar lines on unrectified images of Pendulum

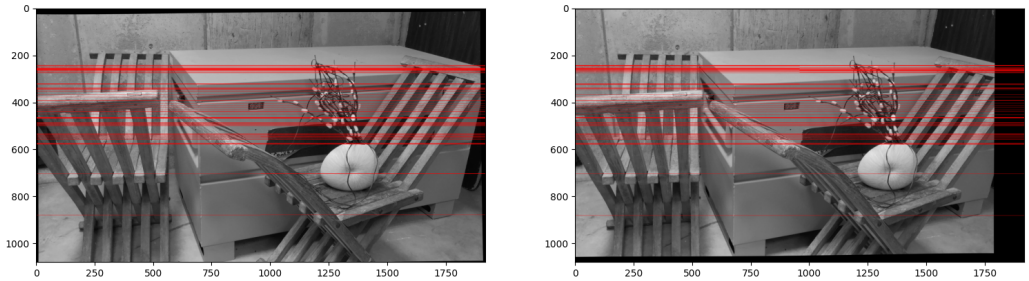

Figure 8: Epipolar lines on rectified images of Curule

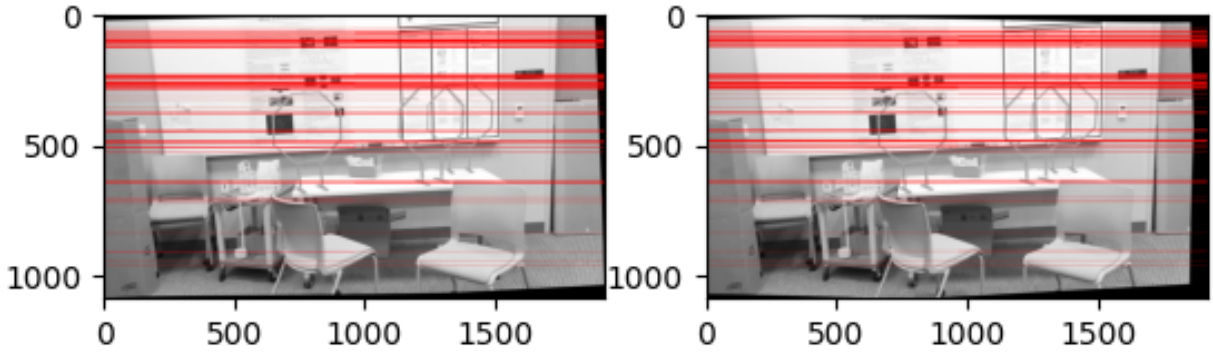

Figure 9: Epipolar lines on rectified images of Octagon

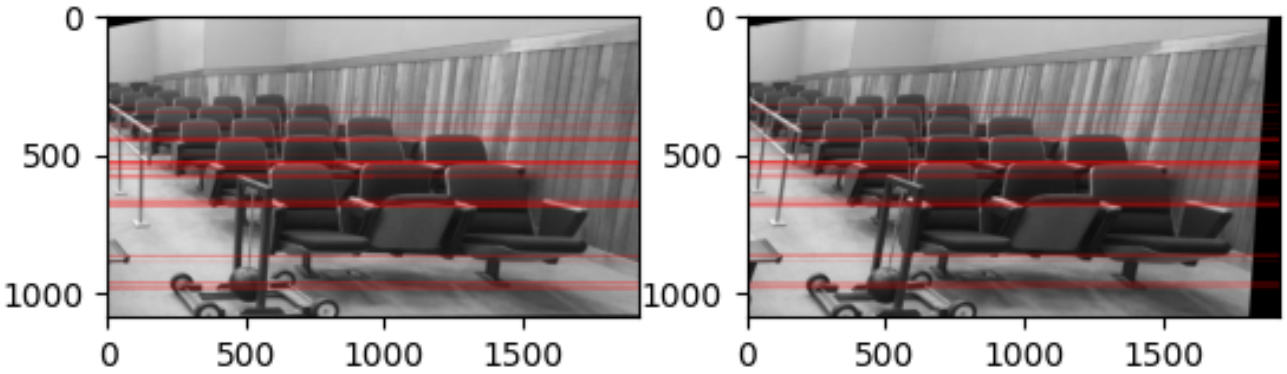

Figure 10: Epipolar lines on rectified images of Pendulum

3 Correspondance

Following are the steps to find the disparity map for the images.

1. Considered an empty image of the same size of the images.

2. Considered a block in the first image and found **SSD** between all the blocks in the same row in the second image till the x coordinate of the first image.

3. The block at the same position as the first image is considered in the empty image.

4. Changed the value of the block with the index value of the minimum SSD block.

5. Scaled the values of the pixels between 0-255.

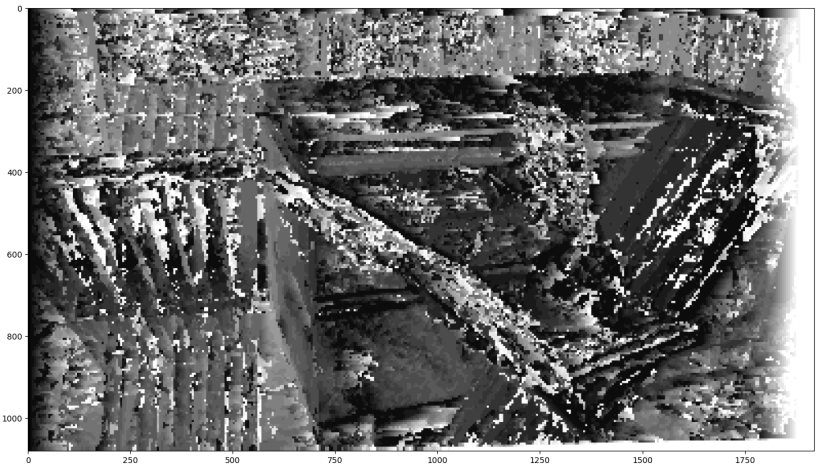

Figure 11: Disparity Image of Curule

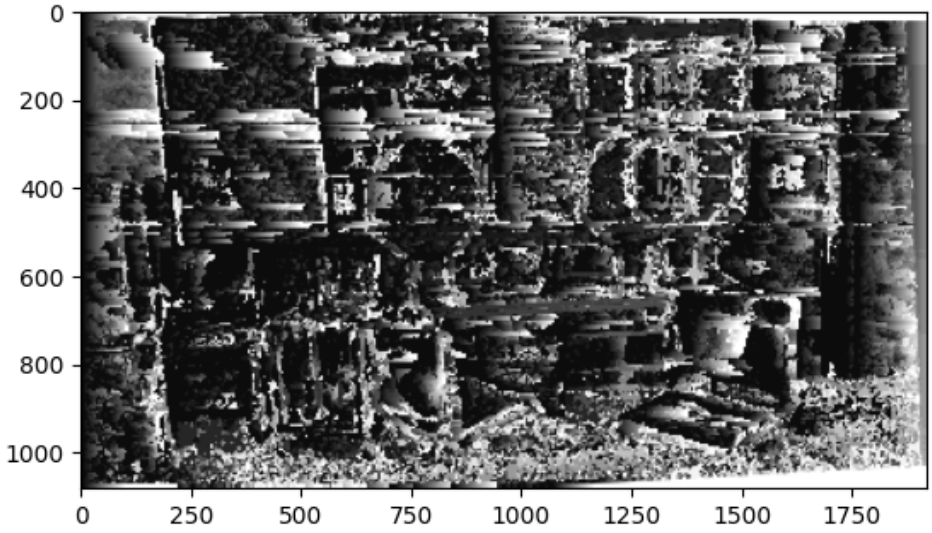

Figure 12: Disparity Image of Octagon

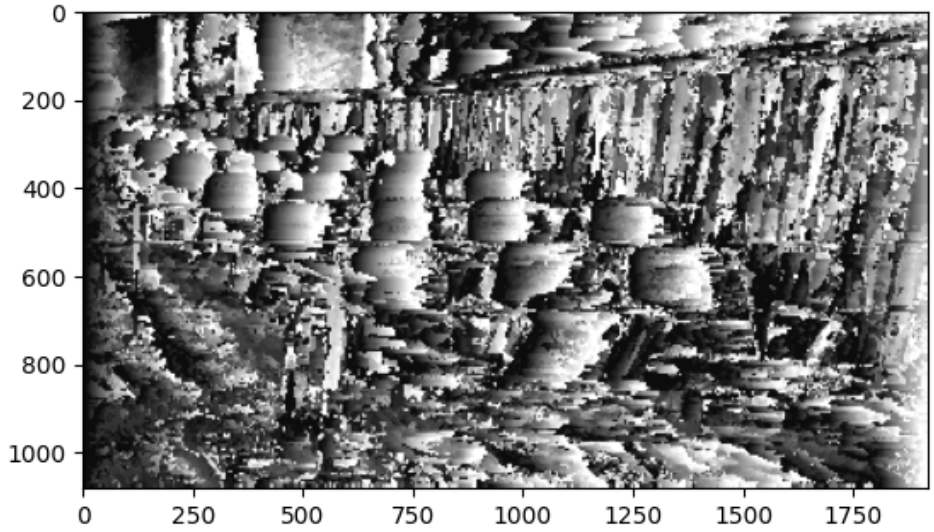

Figure 13: Disparity Image of Curule

4 Depth

Following are the steps to find the disparity map for the images.

1. Computed the depth image as **1/disparity*f*baseline** .
2. Scaled the values of the pixels between 0-255.

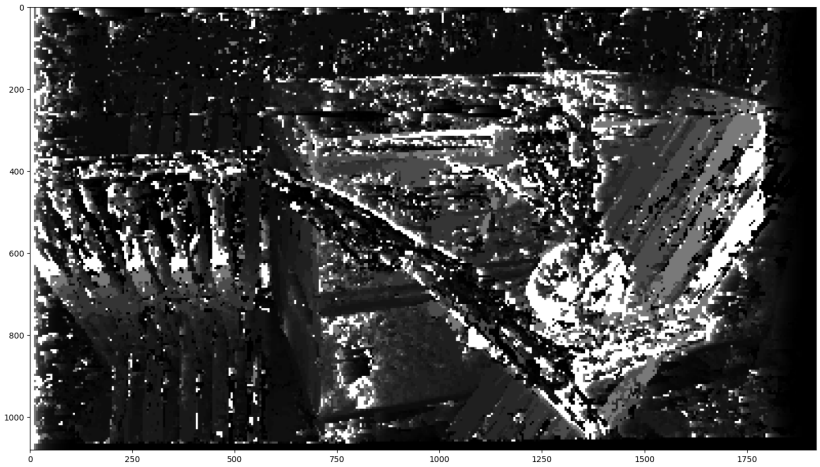

Figure 14: Depth Image for Curule

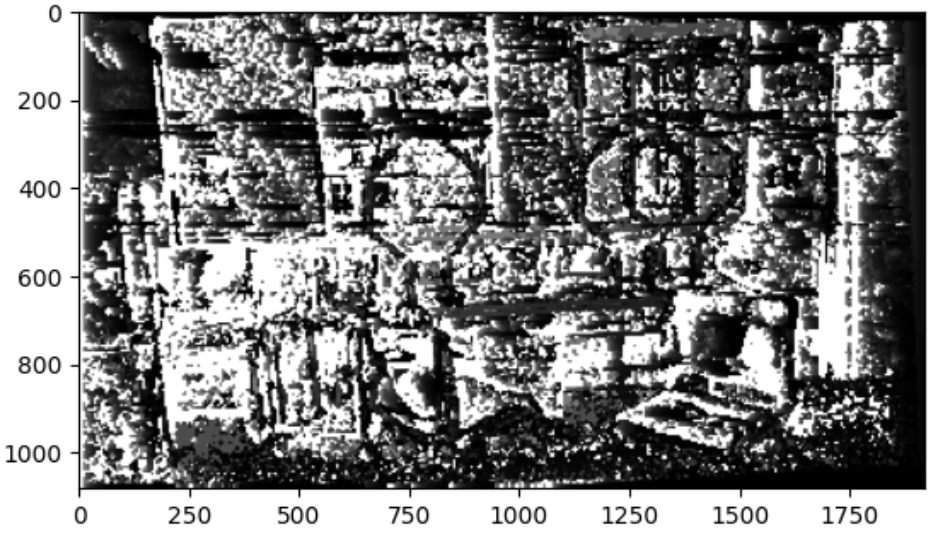

Figure 15: Depth Image for Octagon

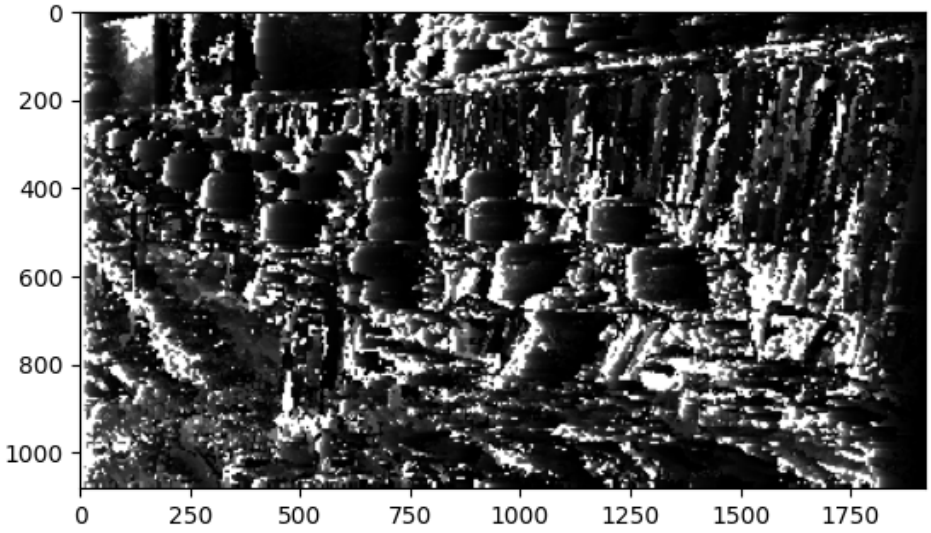

Figure 16: Depth Image for Pendulum