

ENPM673
Perception
Project 3
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(SECTION: 0101)



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LIST OF FIGURES

| | | |
|----|--|---|
| 1 | Q.1.(a) Pipeline | 1 |
| 2 | Fundamental, Essential and Homography Matrices(a) Curule (b) Pendulum (c) Octagon | 2 |
| 3 | Q.1.(b) Pipeline | 2 |
| 4 | Epipolar Lines in original unrectified image for (a) Curule, (b) Pendulum, (c) Octagon | 3 |
| 5 | Epipolar Lines in rectified image for (a) Curule, (b) Pendulum, (c) Octagon | 4 |
| 6 | Q.1.(c) Pipeline | 5 |
| 7 | Disparity Map for (a) Curule, (b) Pendulum, (c) Octagon | 5 |
| 8 | Disparity HeatMap for (a) Curule, (b) Pendulum, (c) Octagon | 6 |
| 9 | Q.1.(d) Pipeline | 6 |
| 10 | Depth Map for (a) Curule, (b) Pendulum, (c) Octagon | 7 |
| 11 | Depth HeatMap for (a) Curule, (b) Pendulum, (c) Octagon | 7 |

CONTENTS

| | |
|-----------------------------------|---|
| List of figures | i |
| I Problem 1: Stereo Vision | 1 |
| I-A Calibration | 1 |
| I-B Rectification | 2 |
| I-C Correspondence | 4 |
| I-D Compute Depth | 5 |

I. PROBLEM 1: STEREO VISION

A. Calibration

The pipeline I have used is shown in Fig. 1.

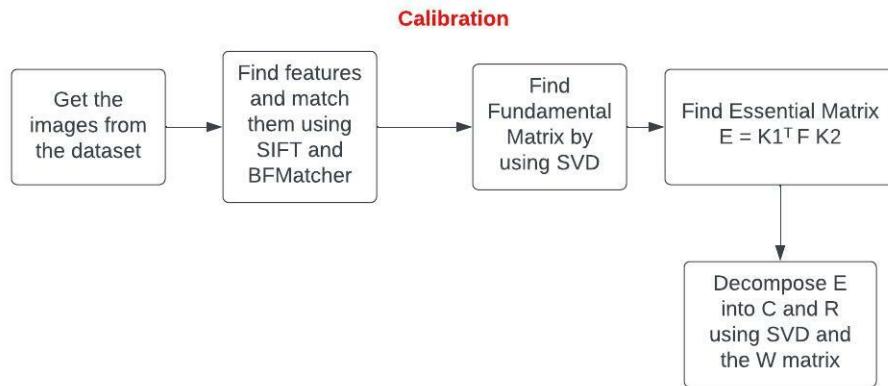


Fig. 1. Q.1.(a) Pipeline

The output is shown in Fig.2. The Fundamental Matrix comes different than that given by inbuilt function because RANSAC parameters need to be tuned.

```

Fundamental Matrix:
[[ 1.99017456e-30  3.37585766e-16 -4.77364159e-15]
 [-7.29202795e-18 -5.55111512e-17 -7.07106781e-01]
 [ 4.27173063e-15  7.07106781e-01  1.09490195e-12]]
calculating em
Essential Matrix:
[[ 4.94722589e-27  8.39198925e-13  2.56784196e-13]
 [-1.81317202e-14 -4.21884749e-15 -1.00000000e+00]
 [ 3.47100894e-16  1.00000000e+00 -3.94129174e-15]]
calculated em
calculating R&C
calculated R&C
H1:
[[ 7.11325966e-01 -4.41727962e-02 -6.68274045e+01]
 [ 2.62076520e-13  7.07106781e-01  1.71780812e-10]
 [ 4.84708304e-16  6.43949730e-16  7.07106781e-01]]
H2:
[[ 1.00000000e+00  2.51053842e-13 -1.35514711e-10]
 [-2.51053842e-13  1.00000000e+00  2.41016096e-10]
 [ 0.00000000e+00  0.00000000e+00  1.00000000e+00]]
Fundamental Matrix:
[[ 2.25084816e-29 -1.21163138e-16 -7.54397410e-14]
 [-8.93333041e-17  5.55111512e-17  7.07106781e-01]
 [ 7.57377101e-14 -7.07106781e-01  2.49683607e-12]]
calculating em
Essential Matrix:
[[ 5.60899980e-26 -3.01425955e-13 -2.01824416e-13]
 [-2.22128396e-13  3.06421555e-14  1.00000000e+00]
 [ 3.73526700e-14 -1.00000000e+00  3.04756220e-14]]
calculated em
calculating R&C
calculated R&C
H1:
[[ -6.17592966e-01 -1.54777851e-02 -4.94730503e+01]
 [ 1.68267009e-13 -7.07106781e-01 -1.32558853e-10]
 [ 2.60683858e-16  1.71350554e-16 -7.07106781e-01]]
H2:
[[ 1.00000000e+00  1.99217204e-13 -1.07547748e-10]
 [-1.99217204e-13  1.00000000e+00  1.91221261e-10]
 [ 0.00000000e+00  0.00000000e+00  1.00000000e+00]]

```

Fig. 2. Fundamental, Essential and Homography Matrices(a) Curule (b) Pendulum (c) Octagon

B. Rectification

The pipeline used for Adaptive Histogram Equalization in Q.1.(a) is shown in Fig. 3.

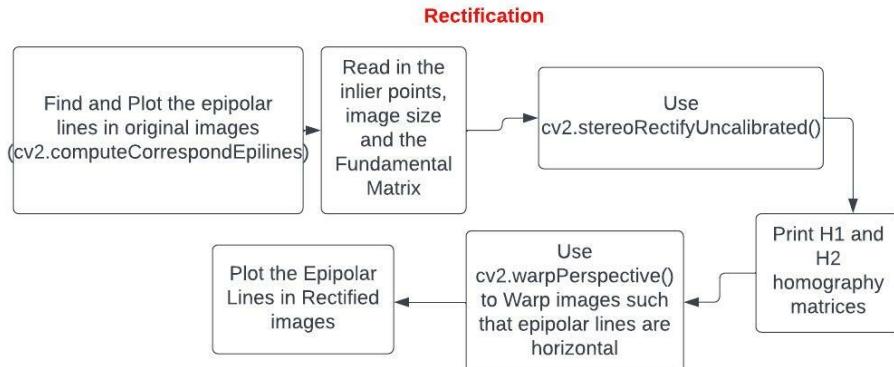


Fig. 3. Q.1.(b) Pipeline

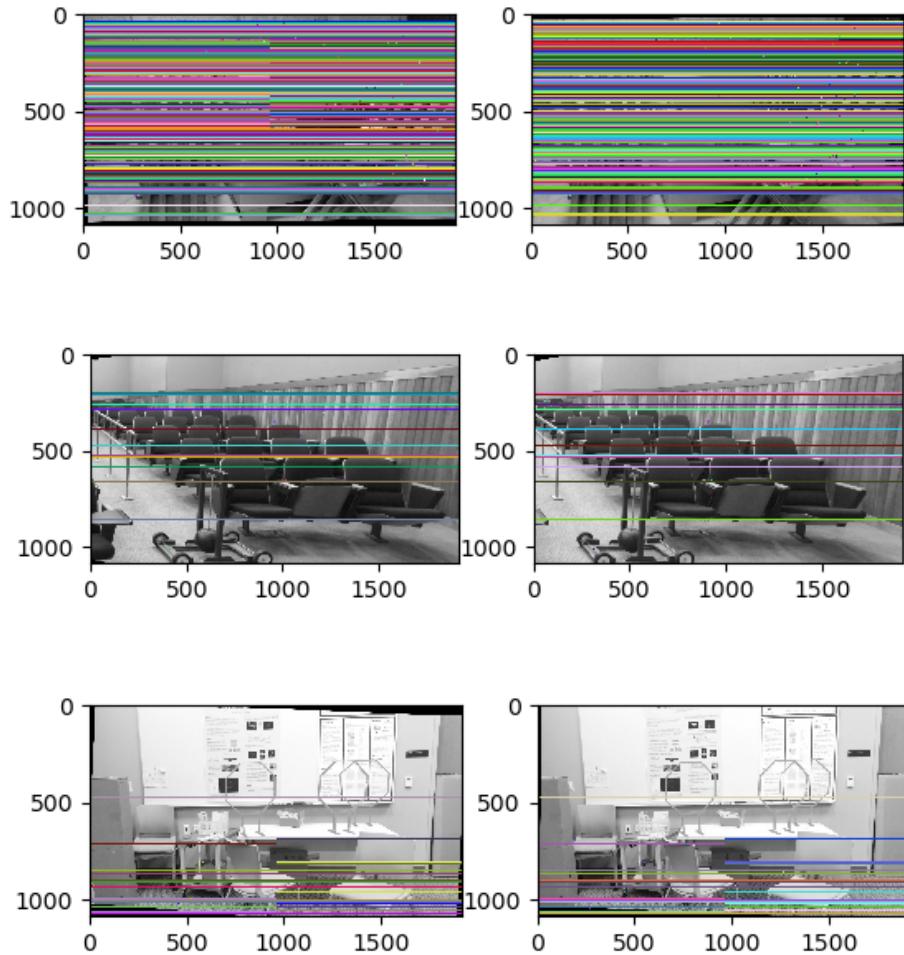


Fig. 4. Epipolar Lines in original unrectified image for (a) Curule, (b) Pendulum, (c) Octagon

The epipolar lines in original image are shown in Fig.4

The epipolar lines in rectified image are shown in Fig.5

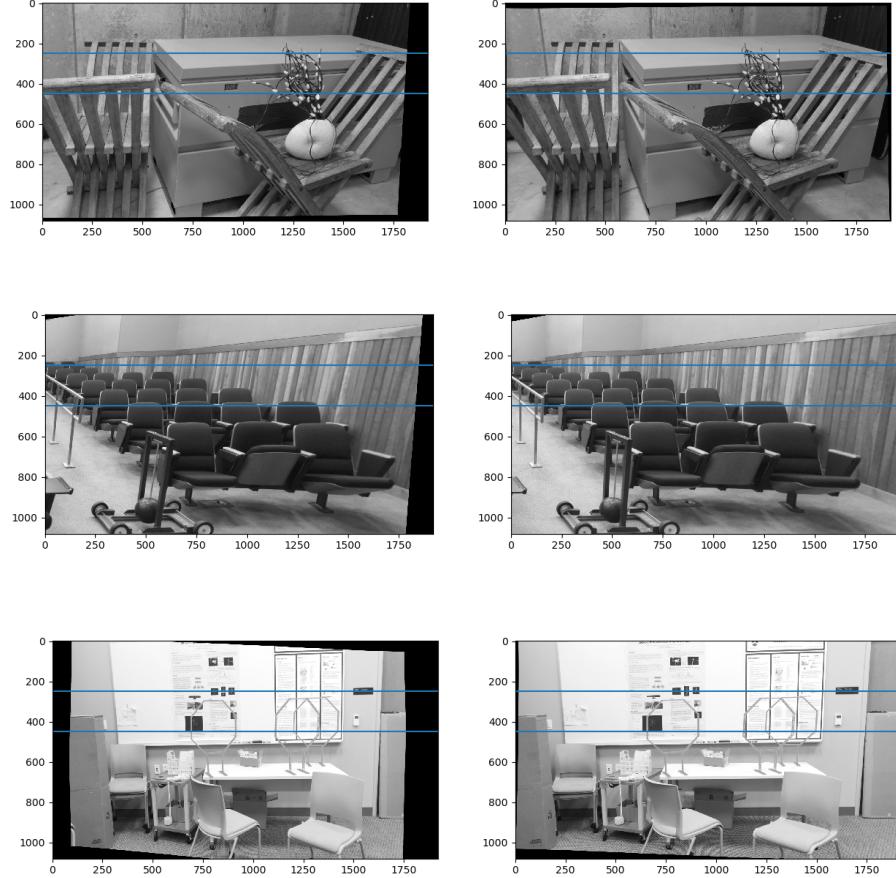


Fig. 5. Epipolar Lines in rectified image for (a) Curule, (b) Pendulum, (c) Octagon

C. Correspondence

The pipeline used for Straight Lane Detection in Q.2. is shown in Fig. 6.

$$\text{Sum of Squared Distances, } SSD = \sum_{i=0}^n (x_{1i} - x_{2i})^2 \quad (1)$$

The grayscale disparity map is shown in Fig.7

The disparity heat map is shown in Fig.8

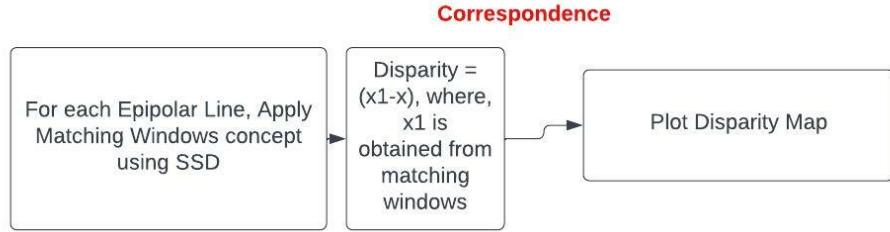


Fig. 6. Q.1.(c) Pipeline

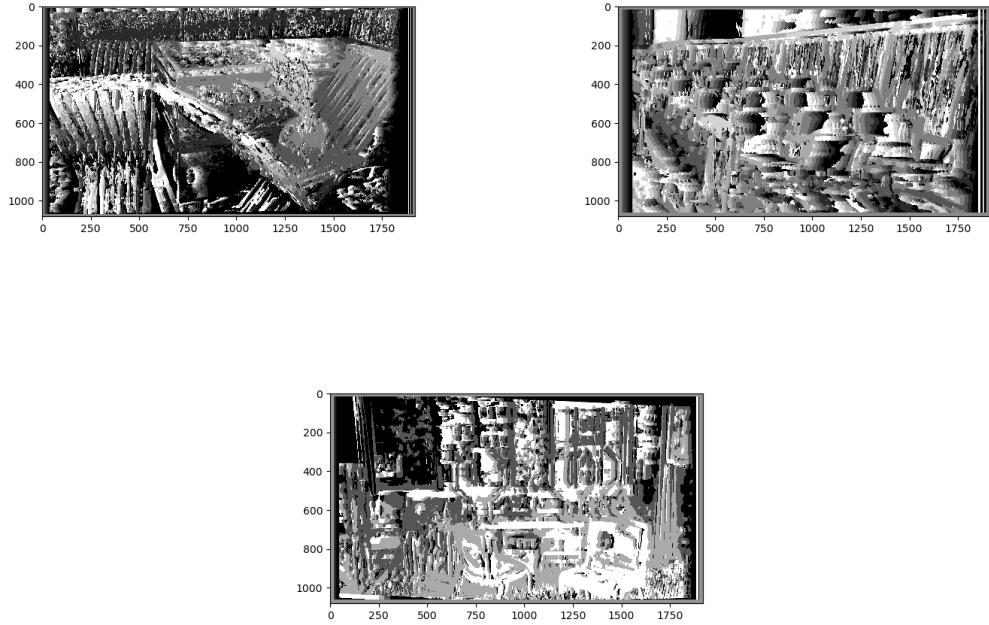


Fig. 7. Disparity Map for (a) Curule, (b) Pendulum, (c) Octagon

D. Compute Depth

$$depth = \frac{baseline \times focal\ length}{disparity} \quad (2)$$

Focal Length is the 1st element of intrinsic matrix K . The pipeline is shown in Fig.9

The grayscale depth map is shown in Fig.10

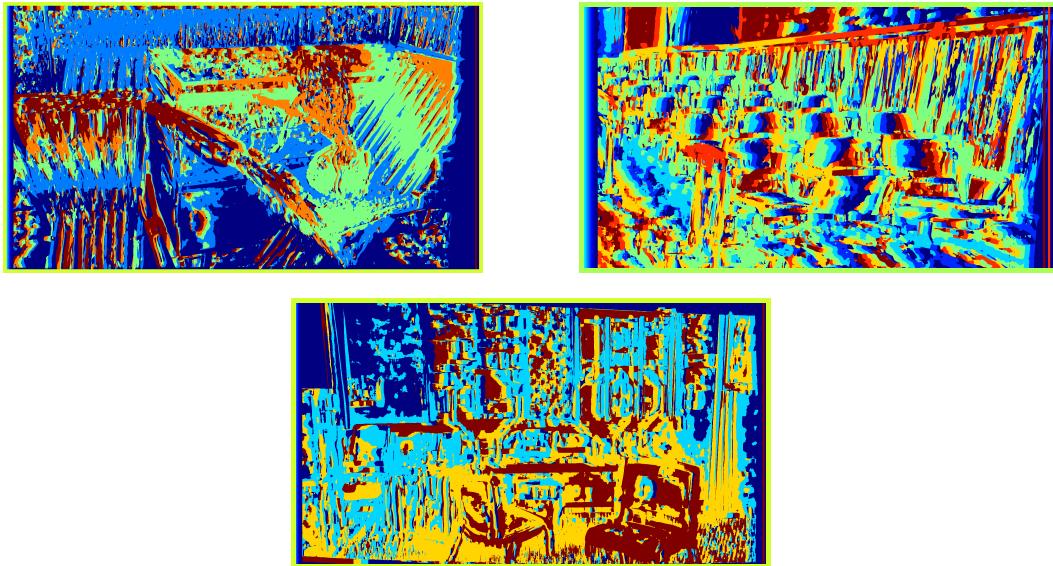


Fig. 8. Disparity HeatMap for (a) Curule, (b) Pendulum, (c) Octagon

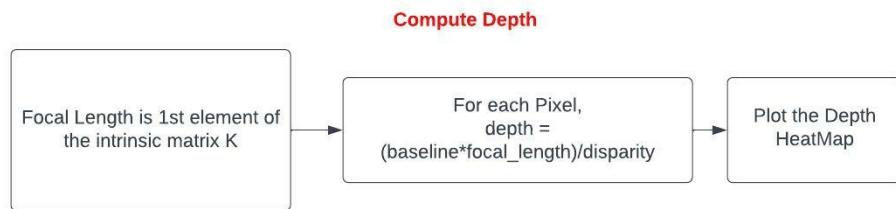


Fig. 9. Q.1.(d) Pipeline

The depth heatmap is shown in Fig.11. As you can see, since SSD based point matching is not a refined method, disparity and depth maps are not accurate.

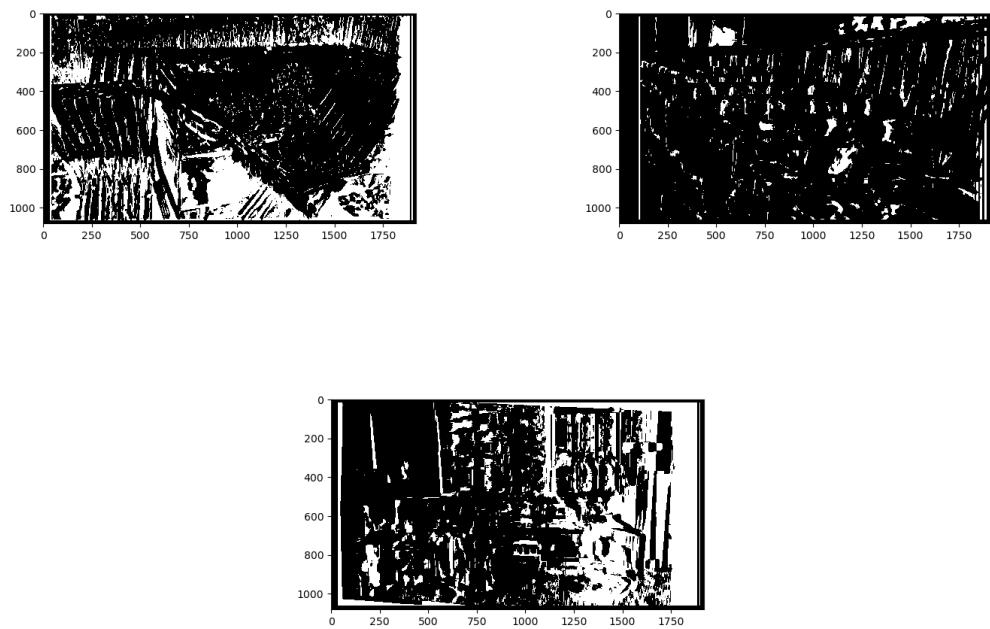


Fig. 10. Depth Map for (a) Curule, (b) Pendulum, (c) Octagon

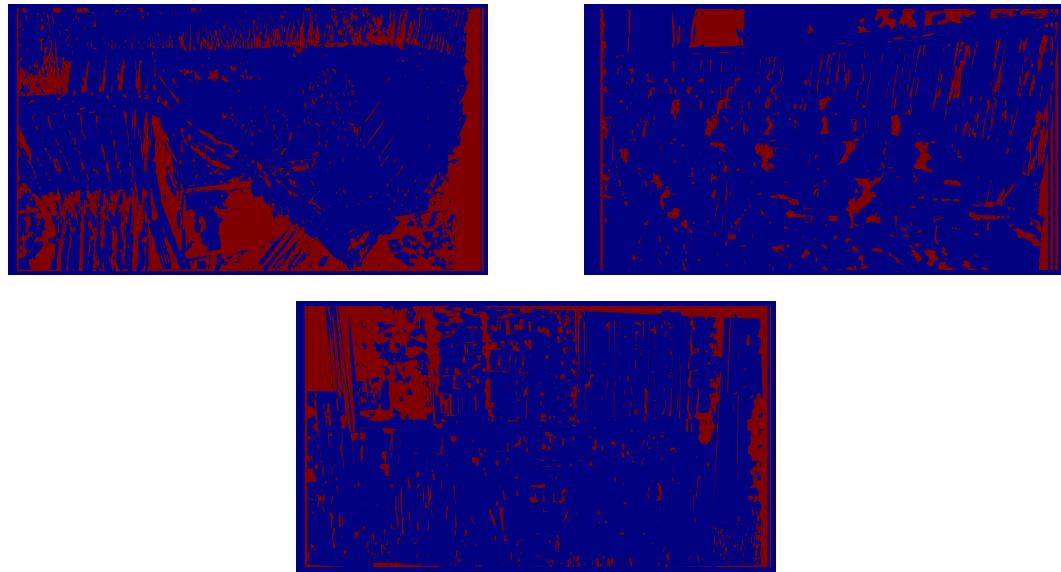


Fig. 11. Depth HeatMap for (a) Curule, (b) Pendulum, (c) Octagon