Contents

ENPM673

Project 3

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1 Calibration

1.1 Feature Matching

In order to Match the feature SIFT was used,the matched features can be seen in Fig 3

Figure 1: Matching Points

Figure 2: Matching Points

Figure 3: Matching Points

These Feature includes lot of outliers, to get rid from them and for best estimation of fundamental matrix, RANSAC performed. 4
RANSAC was performed using Fundamental error $|xj2^T \times F \times xj1|$ where $xj2$ and $xj1$ are feature pair. The error should be nearly zero (0.02 in my case).
Fundamental with RANSAC came out to be:

$$Set1 \quad F = \begin{pmatrix} -4.37415186e-10 & 2.70684439e-07 & -1.16652962e-04 \\ -2.61395326e-07 & -2.15934997e-08 & 2.38278798e-03 \\ 1.17636228e-04 & -2.38491240e-03 & -5.21966757e-03 \end{pmatrix}$$

$$Set2 \quad F = \begin{pmatrix} 2.17278254e-11 & 1.80866108e-07 & -9.90973889e-05 \\ -1.81726128e-07 & 1.55875018e-09 & 2.43137547e-03 \\ 9.88167634e-05 & -2.42720765e-03 & 3.40984566e-03 \end{pmatrix}$$

$$Set3 \quad F = \begin{pmatrix} 4.03329649e-11 & -1.98622834e-09 & -5.24280306e-05 \\ 2.89161802e-10 & 3.03449981e-09 & -2.34451119e-03 \\ 5.32863695e-05 & 2.33879098e-03 & -6.28424137e-03 \end{pmatrix}$$

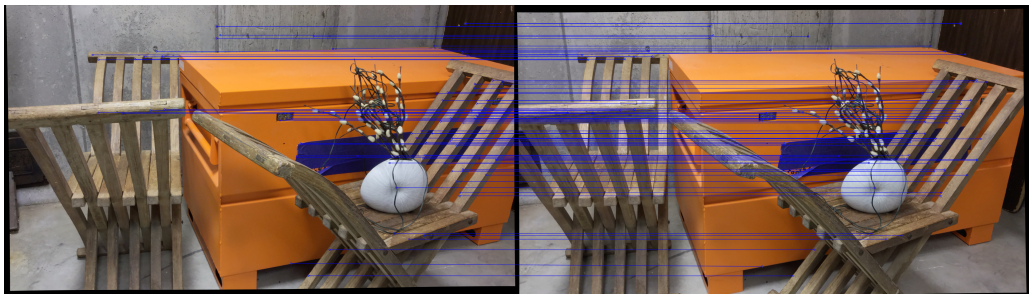

Figure 4: Matching Points after RANSAC

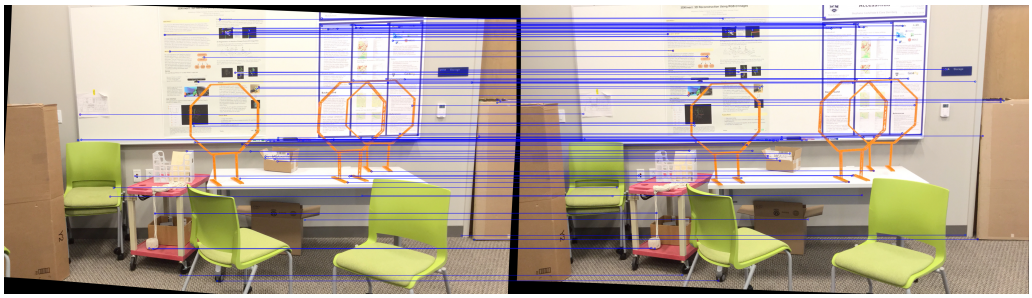

Figure 5: Matching Points after RANSAC

Figure 6: Matching Points after RANSAC

1.2 Extimation of Essential Matrix E

When we have F and Extrinsic Matrix $K_1 and K_2$, Essetial Matrix can be computed using , $K_2^T F K_1$

2 Rectification

Rectification is termed as making both the image frames parallel to each other, This can be done by making epipolar lines parallel to each other. Using the fundamental matrix and the feature points, we can obtain the epipolar lines for both the images.Using the matched image pairs and the estimated F matrix, the images can be rectified using the OpenCV function cv2.stereoRectifyUncalibrated. We will obtain two homography matrices, one for each image, the images were warped in same frame size and epipolar lines were plotted which can be seen in 7 The F also has to change after rectification

$$F_{rectified} = H_2^{-T} F H_1^{-1}$$

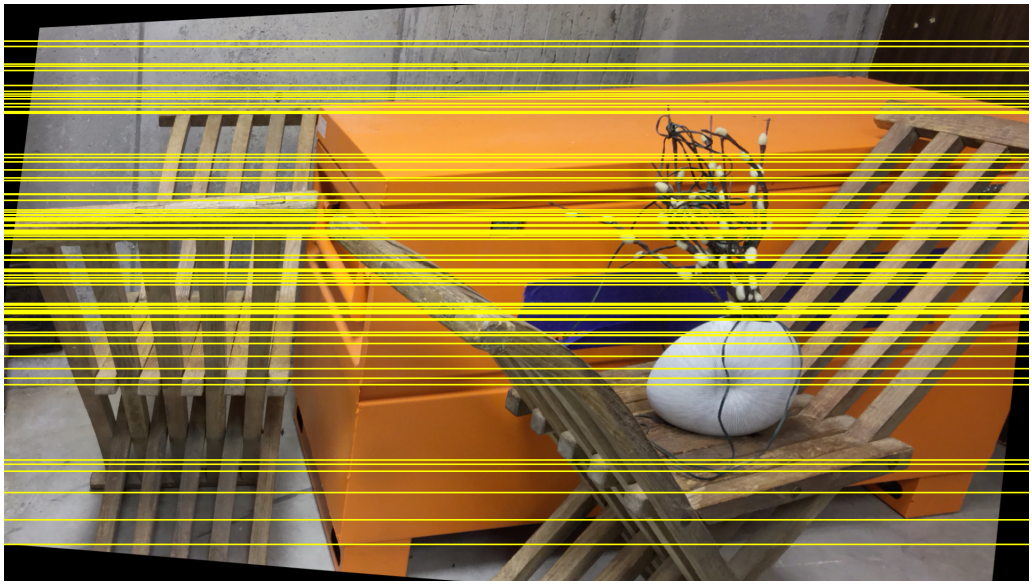

Figure 7: Rectified Image

Figure 8: Rectified Image

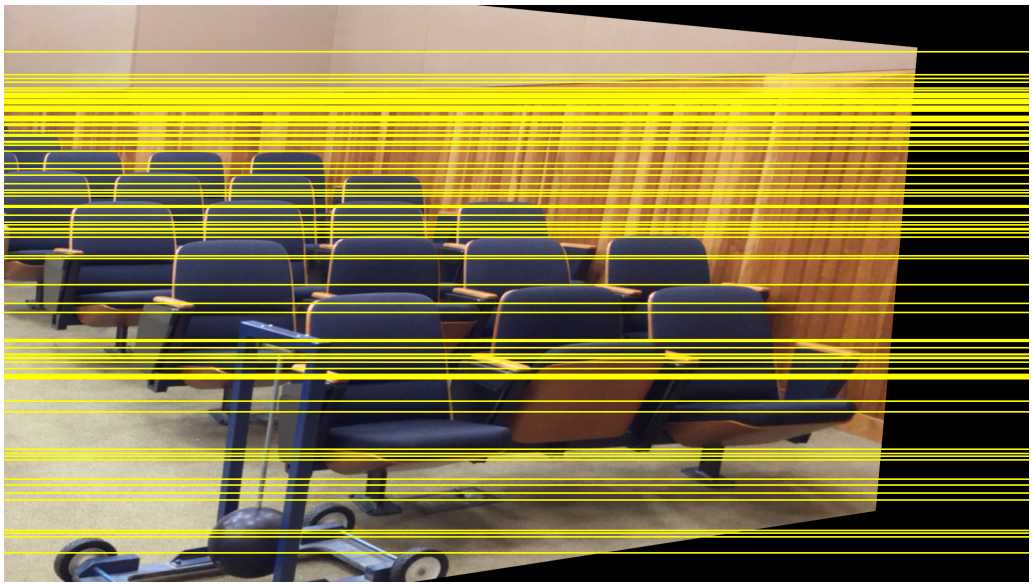

Figure 9: Rectified Image

3 Correspondence

For every pixel in image 1, we will find correspoding pixel match along the epipole line,This can be done using minimizing SSD(Sum of Squared Differences), a window of $11 \times 11 was chosen to get the matched points.$

4 Disparity Map

Now we have matched points, disparity map can be calculated using

$$Disparity_{x,y} = abs(x_1 - x_2)$$

These maps can be seen as

5 Depth Map

Depth of the image pixel can be estimated using

$$Depth = f * baseline/disparity$$

Results can be seen in

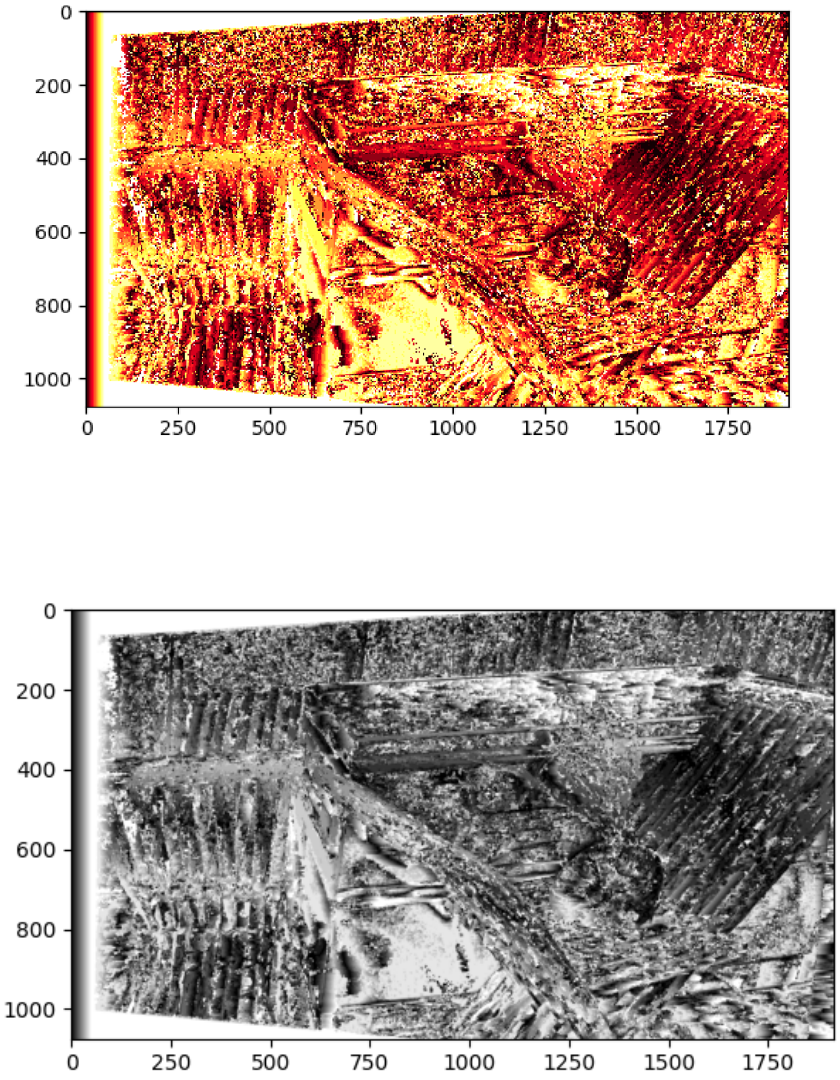

Figure 10: Disparity Image set 1

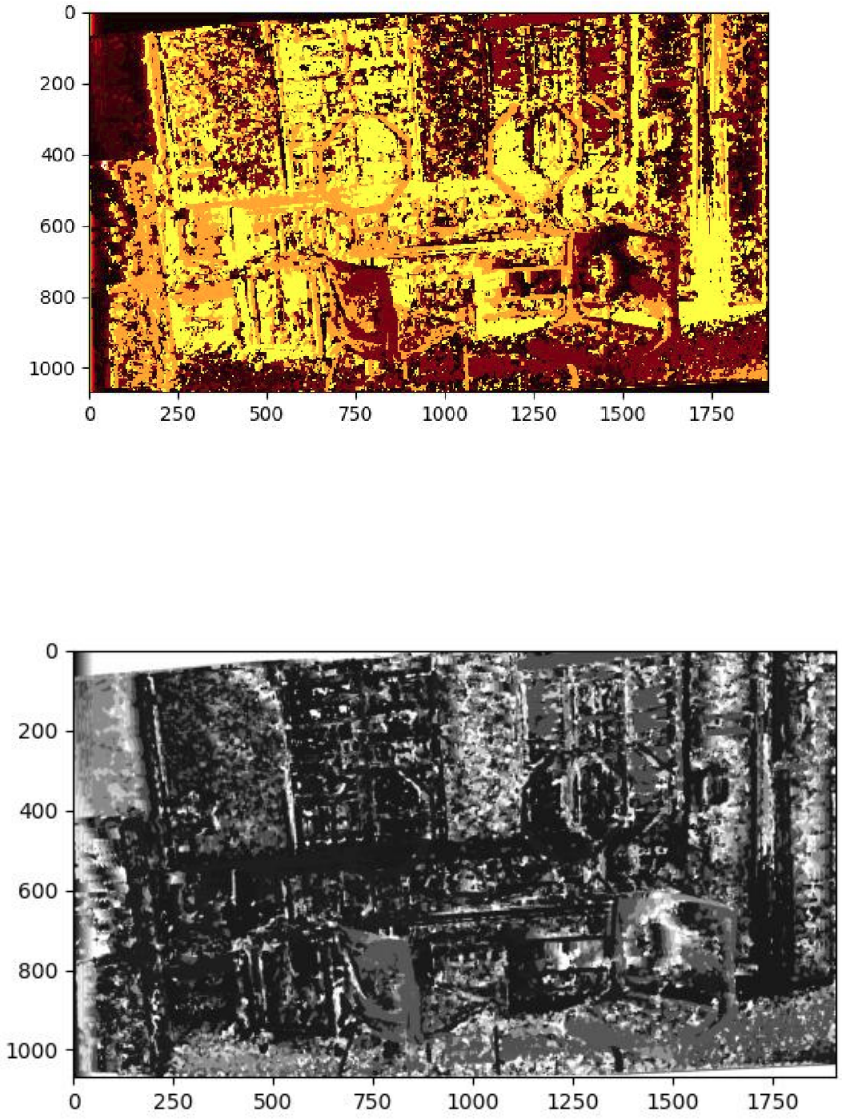

Figure 11: Disparity Image set 2

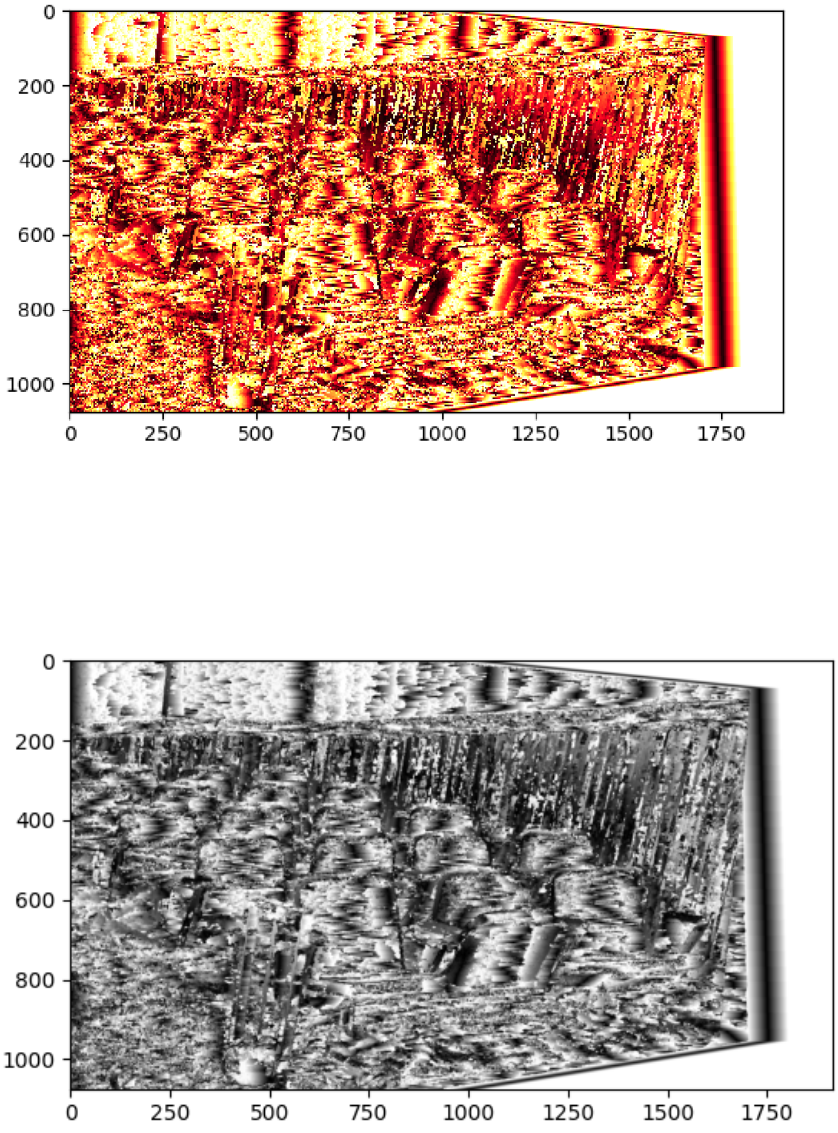

Figure 12: Disparity Image set 3

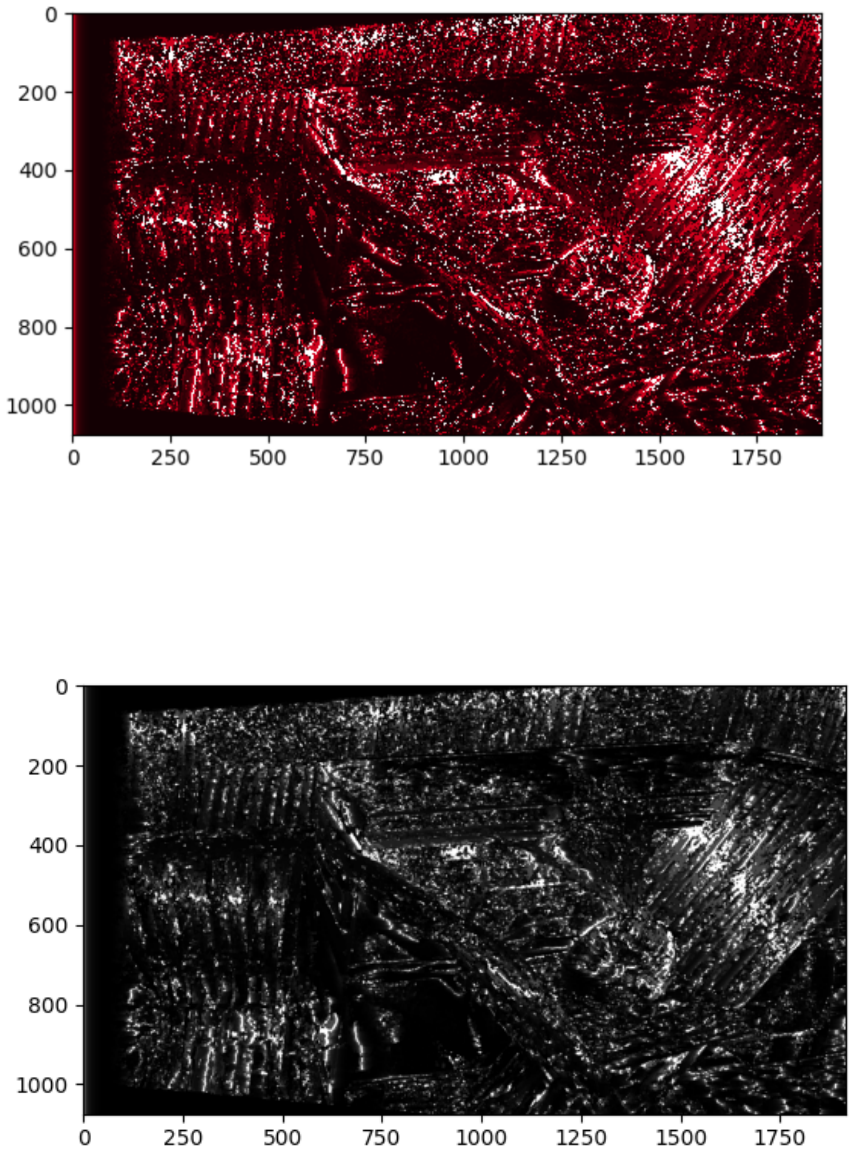

Figure 13: Depth Image set 1

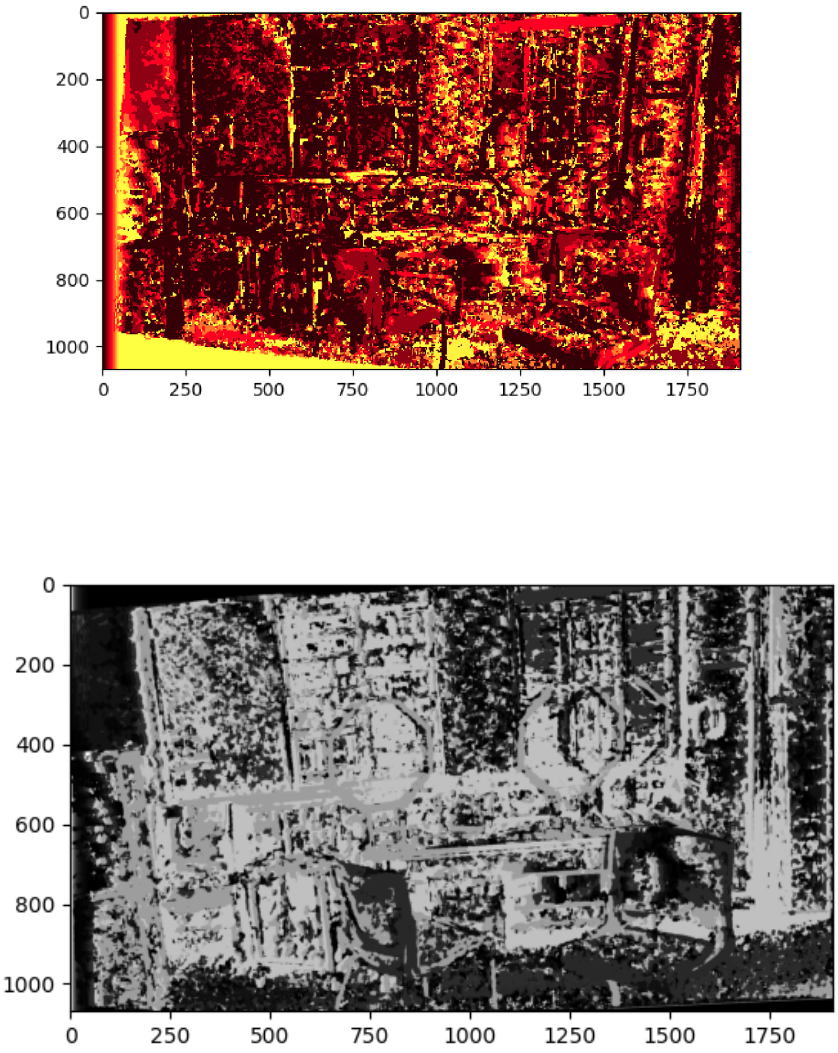

Figure 14: Depth Image set 2

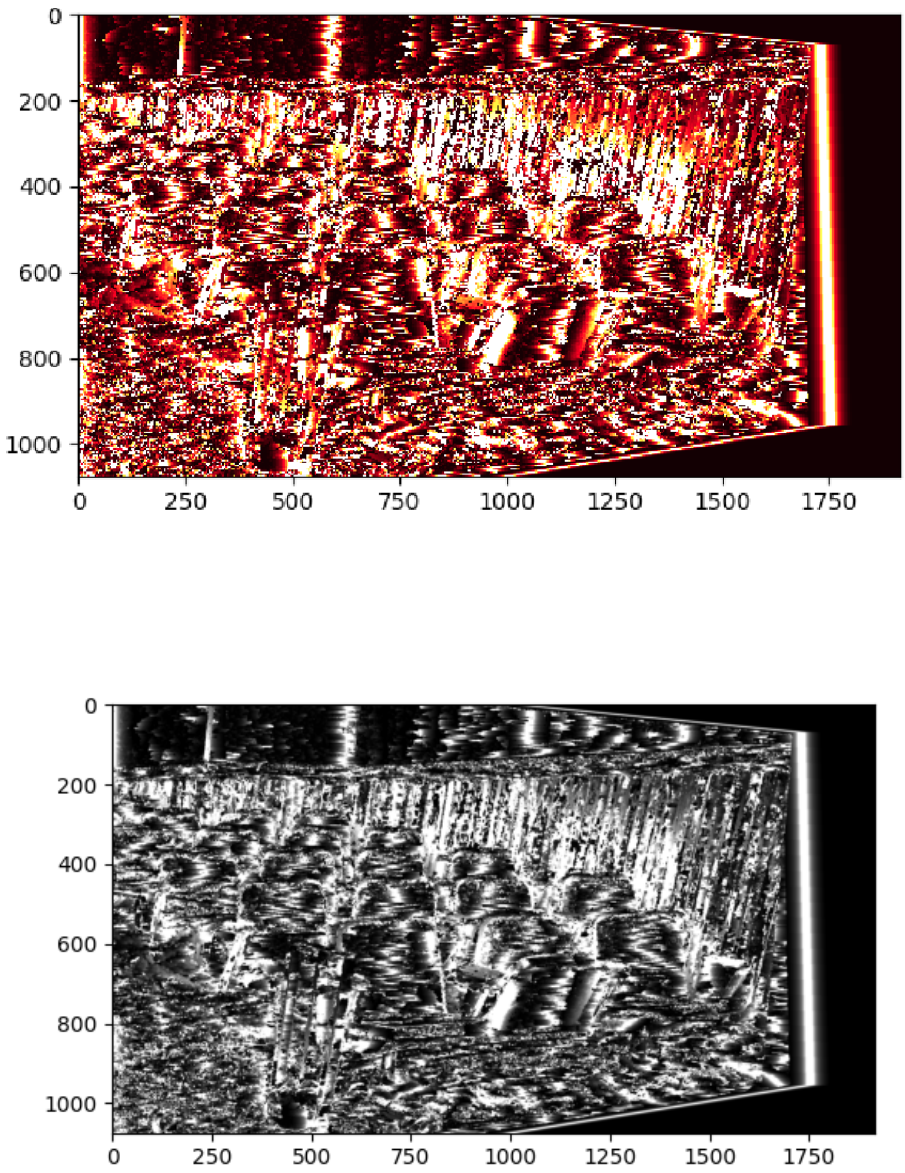

Figure 15: Depth Image set 3