1 Calibration

1. Use the SIFT Feature Extractor to get the common features between the two images.
2. Sort the matches and get the best 'x' number of features.
3. Calculate the image coordinates of the features in both the images
4. using these image points we can calculate the fundamental matrix by minimizing the error using RANSAC
5. We choose 8 random points and use them to estimate the fundamental matrix.

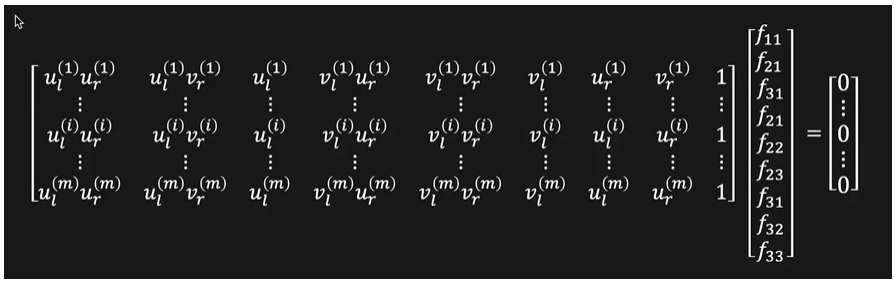

Figure 1: Calculating Fundamental Matrix [1]

6. The fundamental matrix is rank 2 constrained
7. We then get the fundamental matrix with the best fit or the highest amount of inliers.
8. Using the fundamental matrix and the intrinsic matrix (known) we calculate the essential matrix
$$E = K2^T \cdot F \cdot K1$$
9. We obtain the translation and rotation matrices by decomposing the essential matrix using SVD.

2 Rectification

1. Once we get the inliers we use them to compute the epi lines using the OpenCV function $computeCorrespondEpilines()$.

Figure 2: Epi Lines for Artroom Image 1

Figure 3: Epi Lines for Artroom Image 2

2. We also use these points and the fundamental matrix to get the homography of the images using the OpenCV function $stereoRectifyUncalibrated()$.

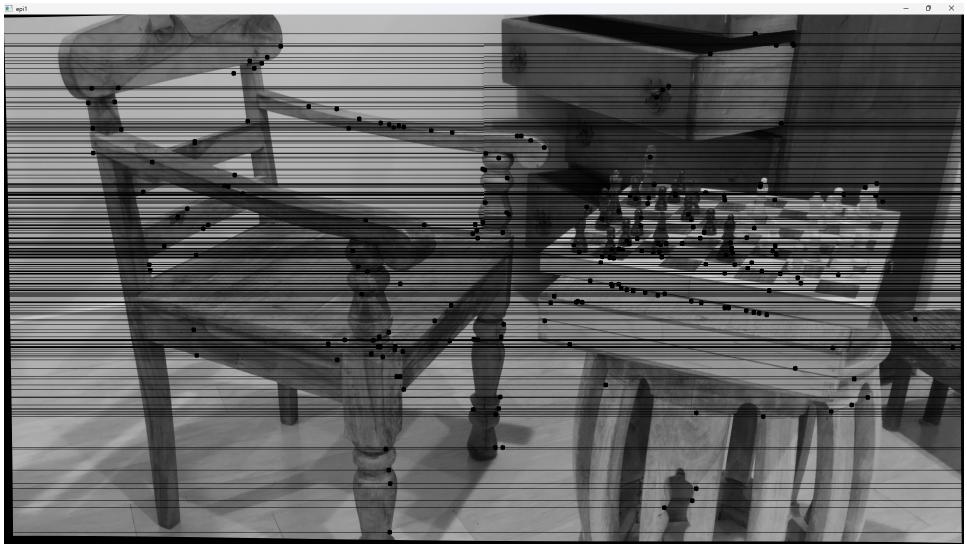

Figure 4: Epi Lines for Chess Image 1

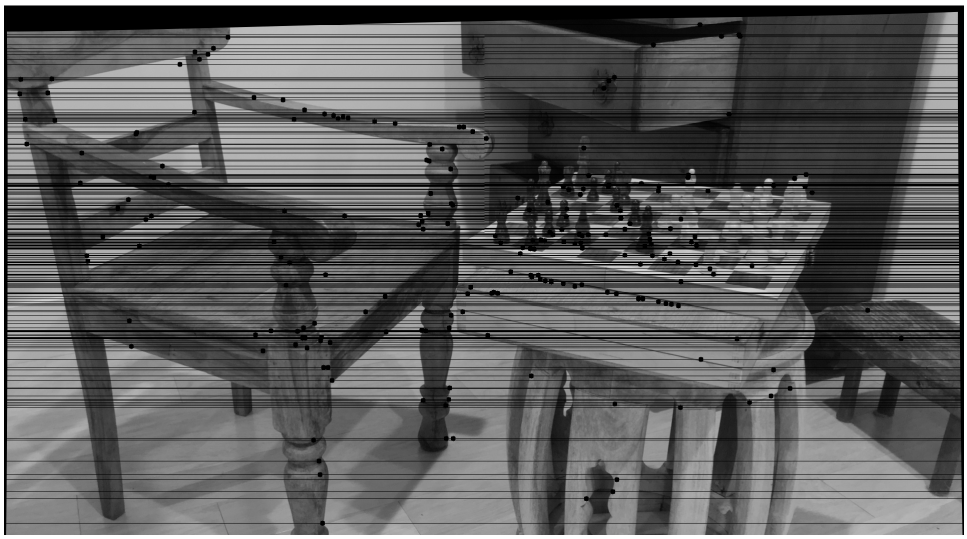

Figure 5: Epi Lines for Chess Image 2

3. Using the homography matrix we then transform the image such that the epi lines are horizontal.

4. This transformed image is the rectified image that we needed.

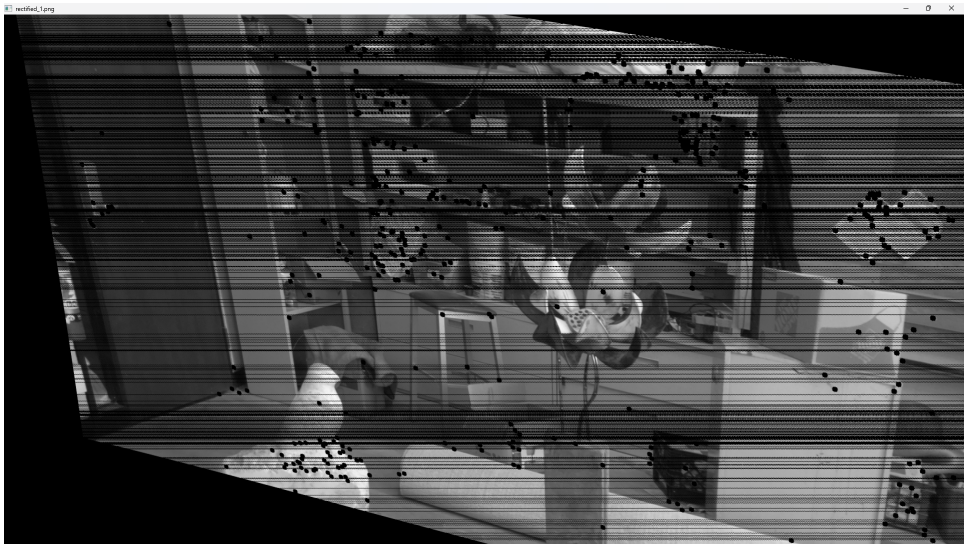

Figure 6: Rectified Artroom Image 1

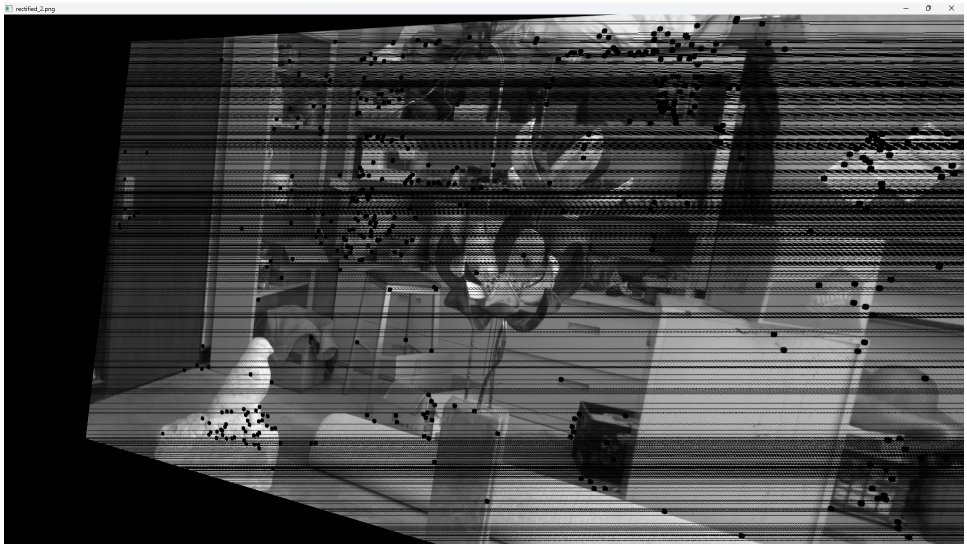

Figure 7: Rectified Artroom Image 2

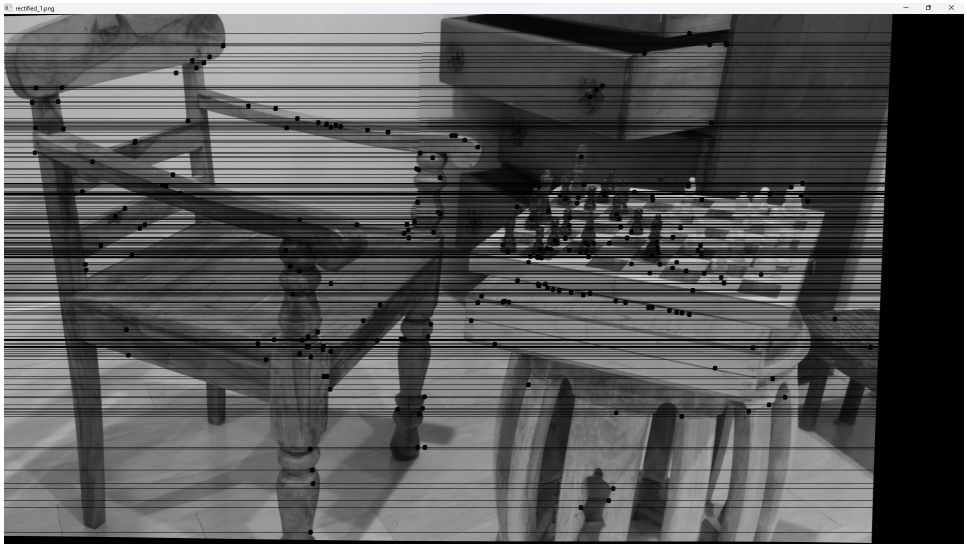

Figure 8: Rectified Chess Image 1

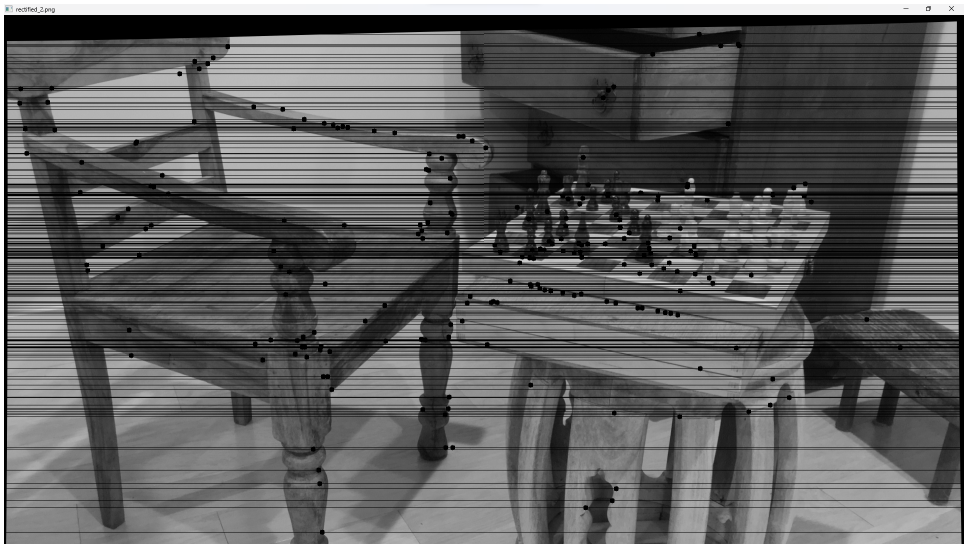

Figure 9: Rectified Chess Image 2

3 Correspondence

1. We then use SSD to get the disparity of the image.
2. We do this by sliding a window along each of the epi lines.
3. We use a scaled down image to lower the compute time.

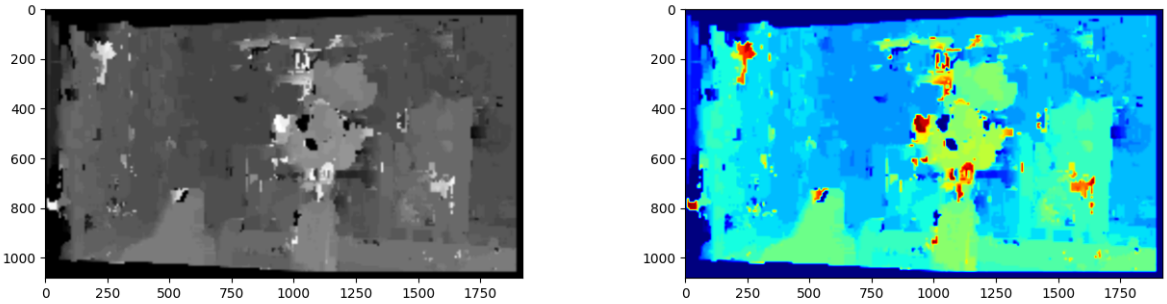

Figure 10: Disparity Heat Map Artroom

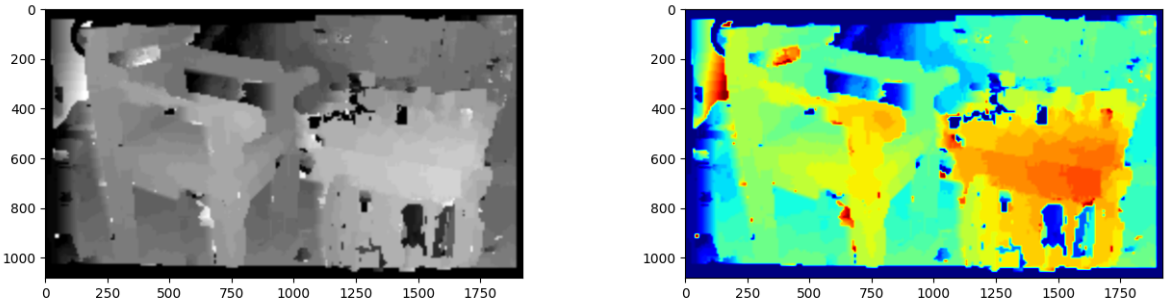

Figure 11: Disparity Heat Map Chess

4. We rescale the disparity values between 0 and 255 to generate a heat map.

Figure 12: Disparity Heat Map Ladder

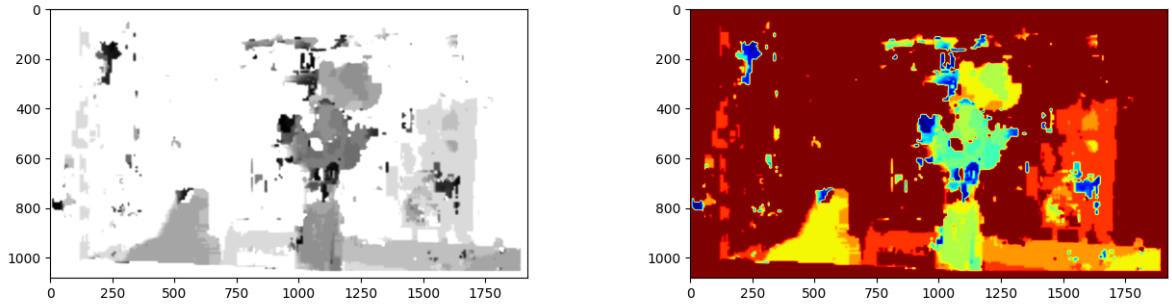

Figure 13: Depth Map Artroom

4 Depth Image

1. Using the disparity values we calculate the depth information

$$depth = \frac{baselinexfocul\_length}{disparity}$$

2. We then rescale it between 0 and 255 to plot it in an image

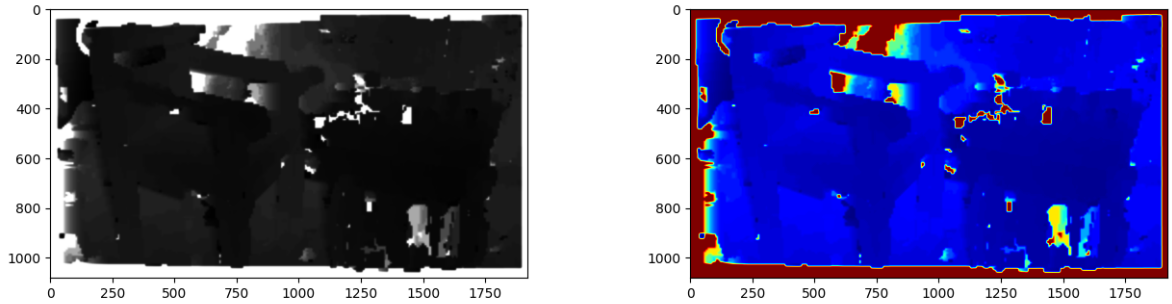

Figure 14: Depth Map Chess

Figure 15: Depth Map Ladder

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