

Computer Vision

Lab 07: Structure from Motion

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In this Lab, we create a very simple structure from motion pipeline.

1 Initialization with epipolar geometry

I start with extracting features of two images that have a large baseline but at the same time a big overlap so that there are enough feature matches. The larger the baseline, the better the triangulation of the feature points.

- I took the first and the last image of the sequence, extracted their SIFT features and matched them using VLFeat library
- Then, I ran 8-point RANSAC to compute the inlier-set and then computed the essential matrix from the fundamental matrix and the camera parameters. I decomposed the essential matrix into R and t and created the projection matrix for the second view assuming that the projection matrix for the first view is $[I | 0]$
- Finally, I triangulated the calibrated matched inlier features and store their 3D positions. Now, I have 3D-2D point correspondences for the inlier features.

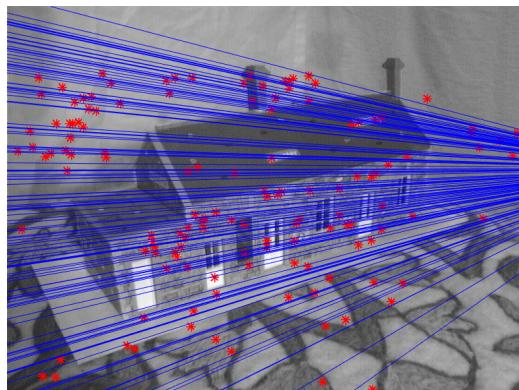


Figure 1. Epipolar lines of first image

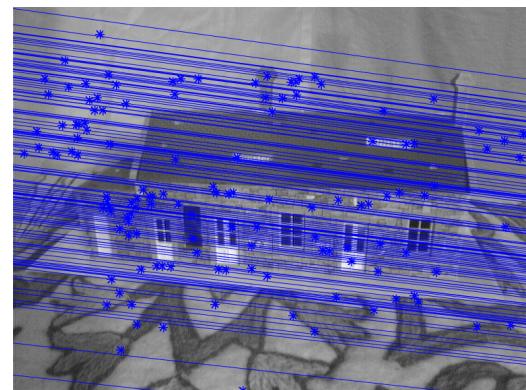


Figure 2. Epipolar lines of last image

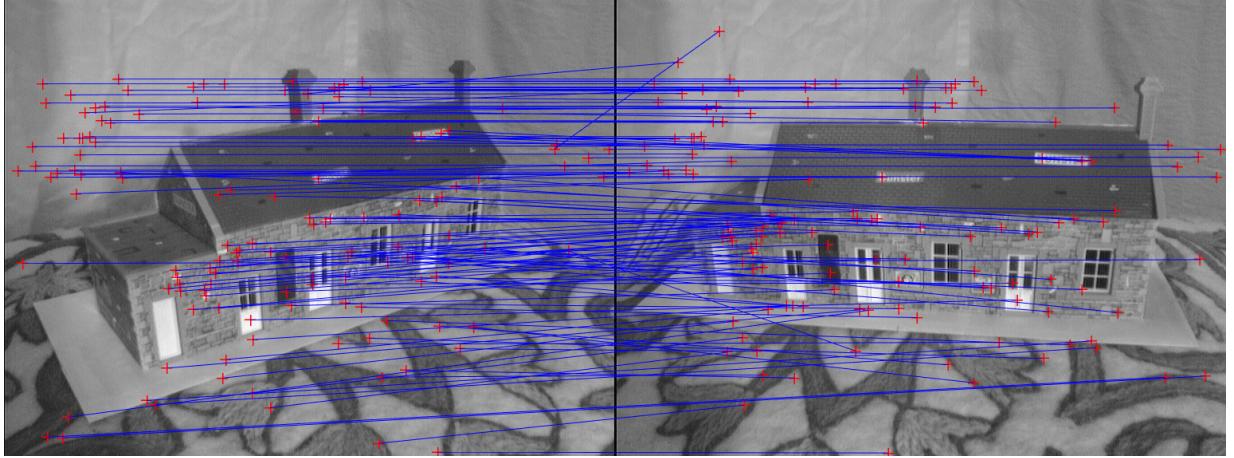


Figure 3. Inliers in the image pair 0-4

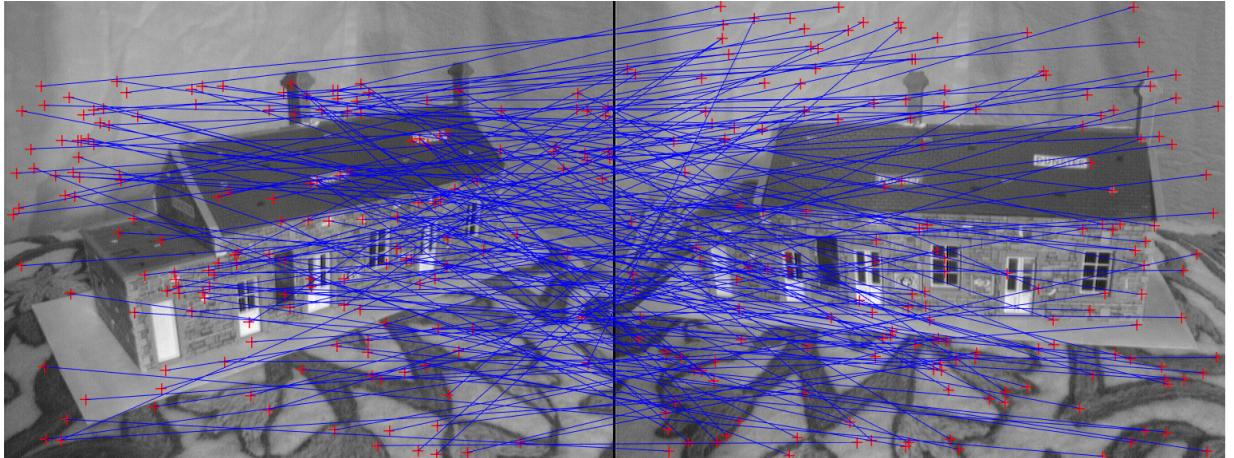


Figure 4. Outliers in the image pair 0-4

2 Adding new views

Next, I add additional views of the scene by matching 2D features in the new view and one of the existing views. These matches represent now also 3D-2D correspondences, the 2D point from the new image and the 3D from the 3D-2D correspondence of the existing view.

To find the pose of the new camera relative to the scene (the P matrix) I used the 6-point DLT algorithm. To filter out wrong matches, use a 6-point RANSAC, that uses the reprojection error as error measure. I checked if the determinant of the projection matrix is negative, and corrected it by multiplying its elements with -1. I repeated this exact process 3 times in order to add the remaining images.

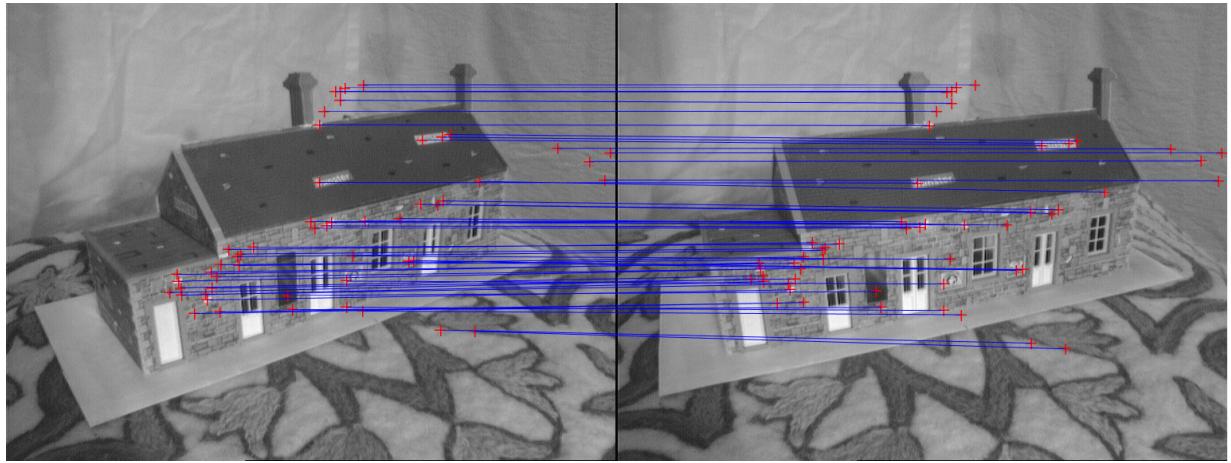


Figure 5. Inliers in the image pair 0-1

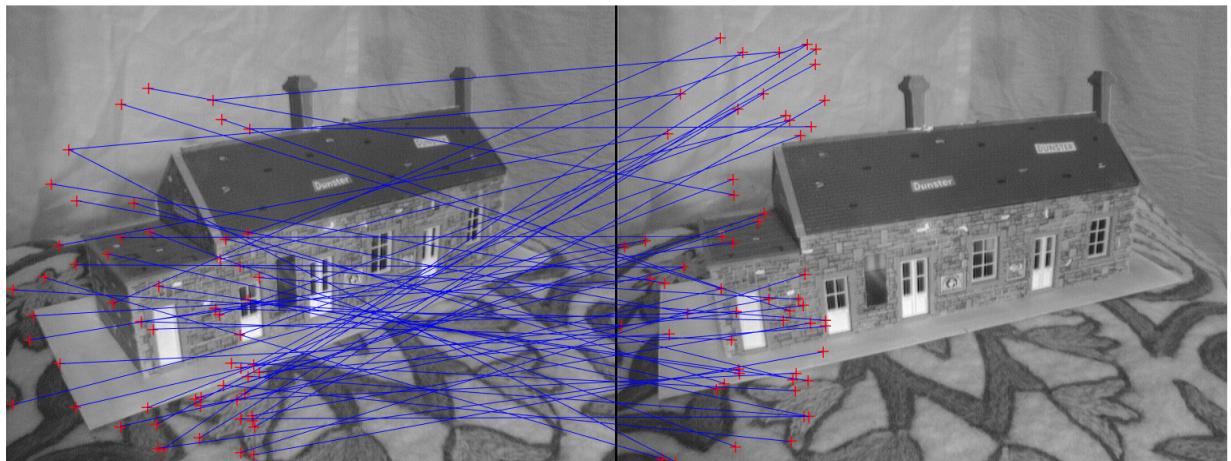


Figure 6. Outliers in the image pair 0-1

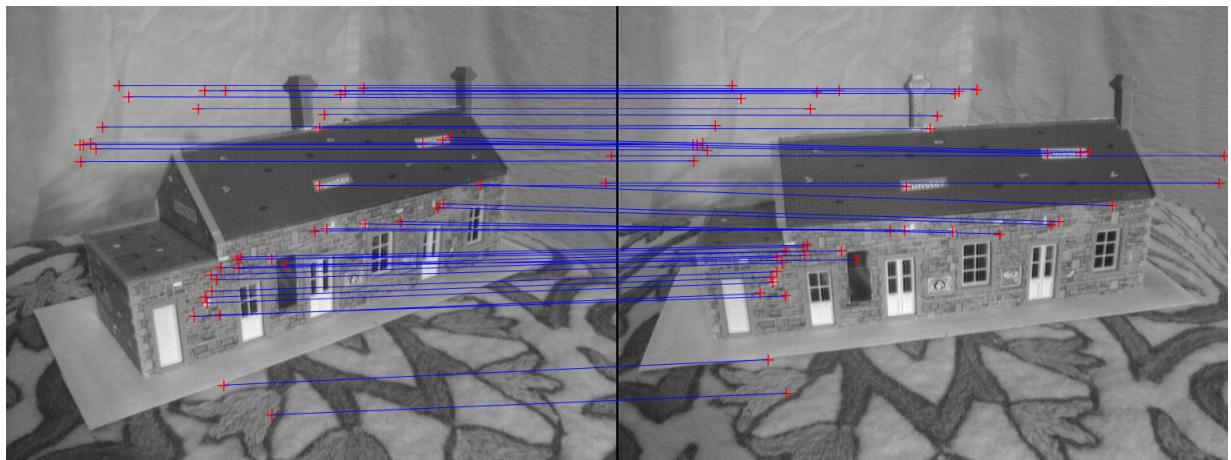


Figure 7. Inliers in the image pair 0-2

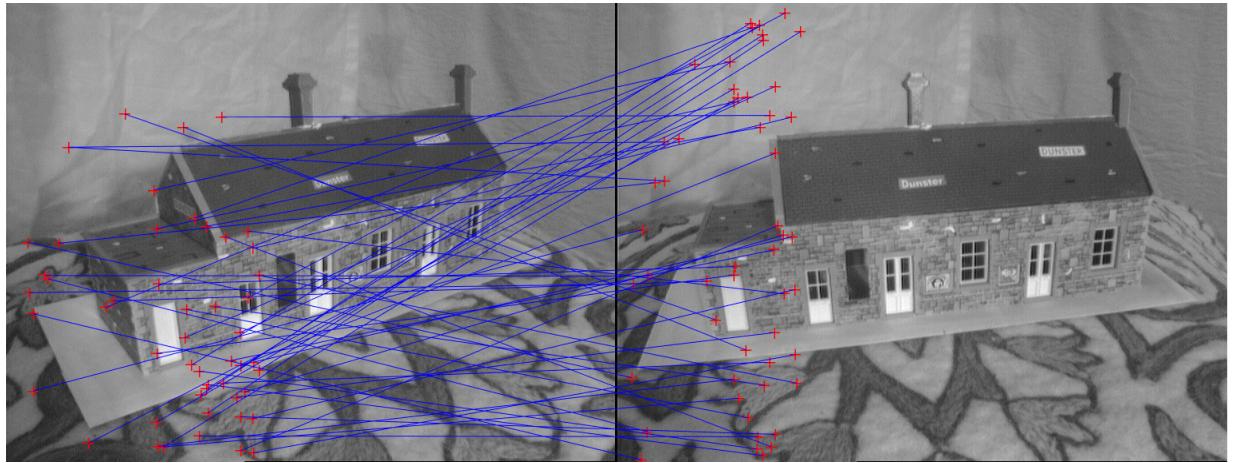


Figure 8. Outliers in the image pair 0-2

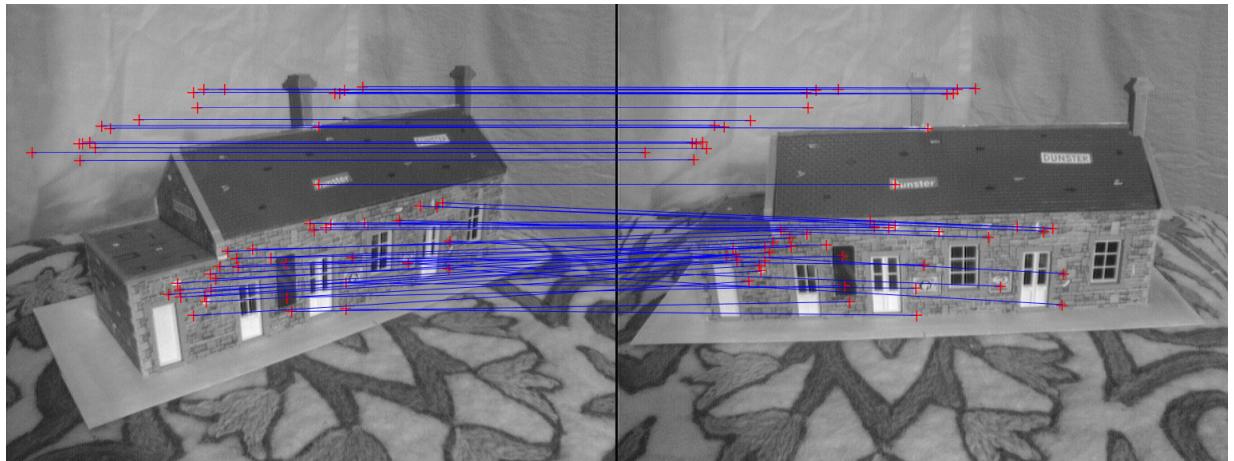


Figure 9. Inliers in the image pair 0-3

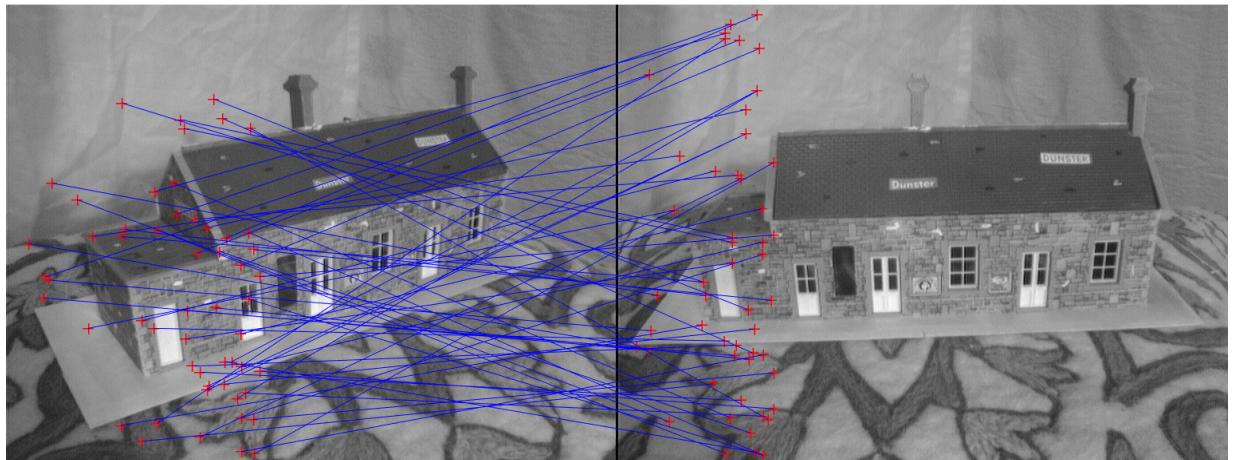


Figure 10. Outliers in the image pair 0-3

3 Visualize the camera poses

To analyze our results, I triangulated all inlier matches from very view addition and plotted them in 3D. I also visualized the camera poses of every view.

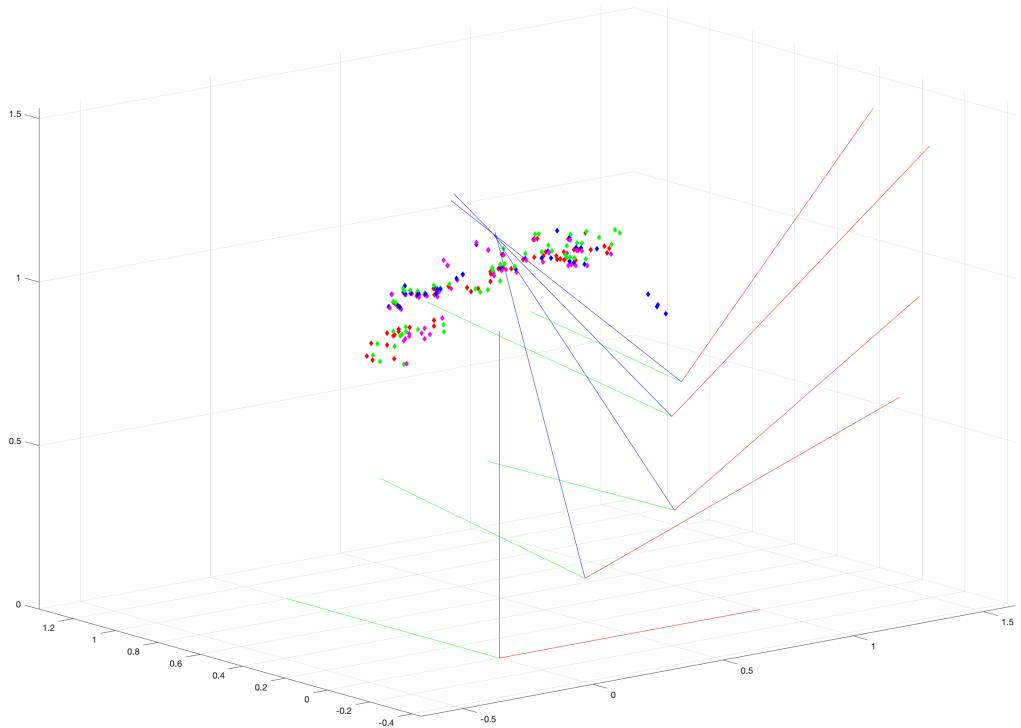


Figure 11. Camera poses and triangulated feature points

4 Dense Reconstruction

I attempted to do dense reconstruction for the scene and successfully generated the rectified images, mtl and obj files of the stereo matching using graph-cut. But even after having the entire machinery, for some reason the visualization on the MeshLab was blank.

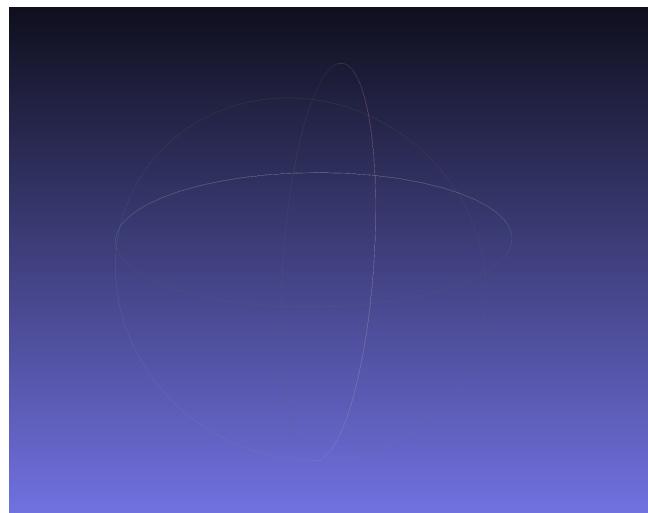


Figure 12. Camera poses and triangulated feature points