Bachelor-Project
SS 2021

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Camera Pose Estimation for Ushichka Dataset
Status Report 2

Camera Projection Matrix

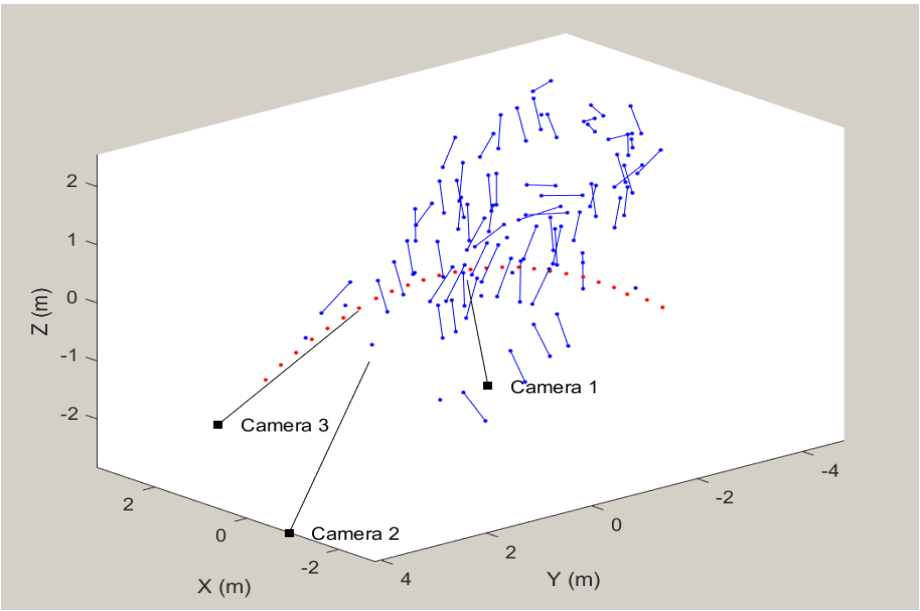

Figure 1: EasyWand Calibration

The major focus for this step was to include the existing calibration data to improve the accuracy of the reconstructed point cloud. It was more difficult than expected as the data was presented in multiple formats and needed to be converted to the conventions used in matlab and my scripts. Figure 1 shows the calibration file for round 4, opened in EasyWand [1]. As the calibration supposedly was created using this software, it helped as ground truth orientation in the process.
Finally, I was able to extract the data correctly. The correctness can be demonstrated by drawing a *Unit-Cube*, a cube of size 1 placed at the origin, in the scene and projecting it down to the individual images using the calibrated camera projection matrices. You can see the result in figure 2. The corners of the Box are colored to underline the the orientation in the individual images.

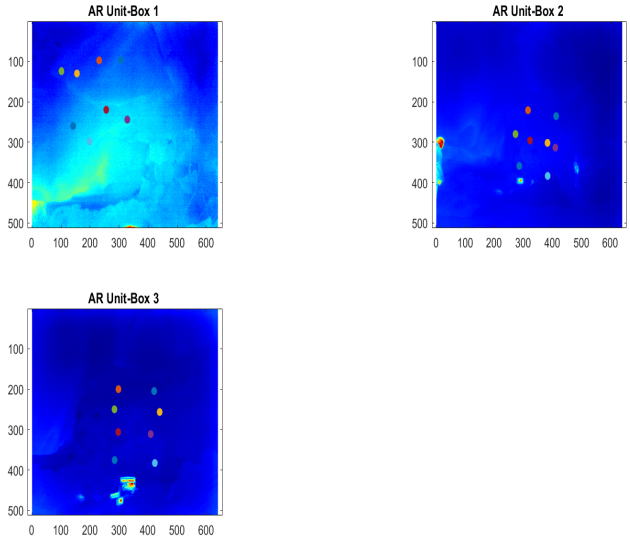

Figure 2: Projected Box

Fundamental Matrix

The projection matrices can be used to calculate the fundamental matrix. The calibration data also helped in stating the camera intrinsic Matrices more precisely, so every known fundamental matrix corresponds to a known essential matrix and as a consequence camera position and rotation[1].
Figures 3 and 4 visualize the fundamental matrix on the artificial unit cube and real world SIFT feature matches.

Reconstruction and Next Steps

The improved accuracy and stability, results in a sparse reconstruction (figure **??**), that is well shaped in comparison to the previous report. A 3D median filter also helped in improving matching accuracy. However, the detail is not enough for the point cloud to confidently be identified in the lidar scan.
The current goal is to densify the reconstruction and to expand the correspondences into the complete image, as the matches currently only occupy a small region.

Currently, I am working on dense stereo approaches to compute a depth map

[1] In the reference frame of the thermal cameras, as defined by calibration

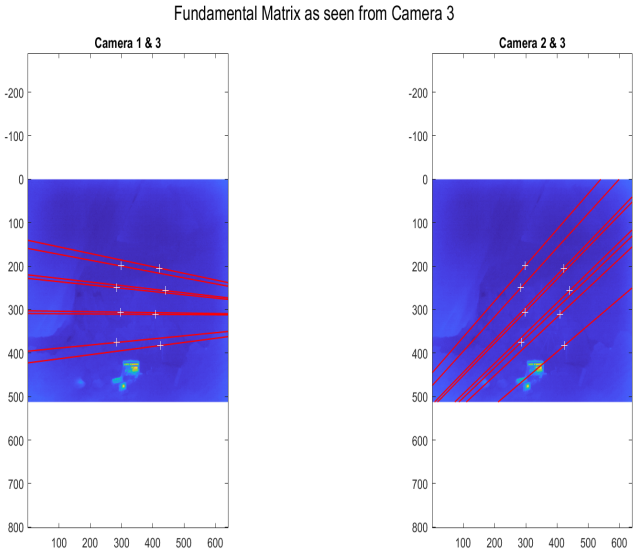

Figure 3: Fundamental Matrices, Unit-Cube

of the scene. Figure 6 shows a rectified image pair that is used to compute the depth map. However, I have not yet verified if it really is a correct rectification, some points seem to have a vertical disparity $> 30px$. Also, the depth map shows no useful results at the moment. It was calculated using semi-global matching.
Maybe more parameter tweaking or a more robust algorithm is needed. There may also be the possibility that the cameras don't satisfy the constraints for dense stereo as they don't exactly look in the same direction [2].

I am also considering feature tracking to obtain more correspondences and maybe multi-view stereo approaches.

[2] I'm not sure if this really is a problem as in theory two images could be projected into the same orientation using homographies

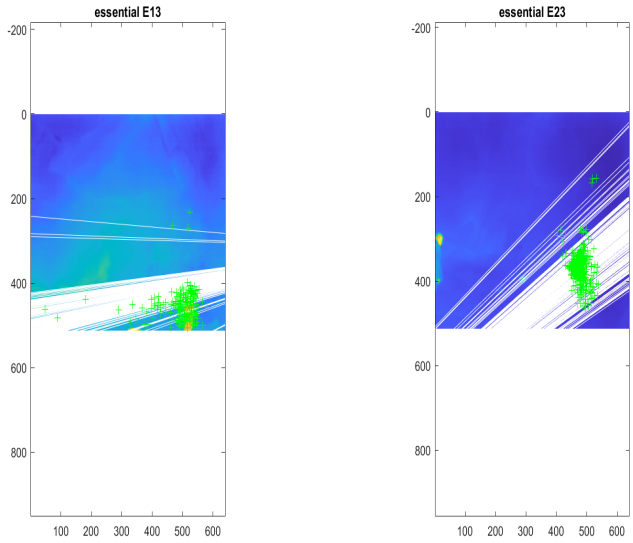

Figure 4: Fundamental Matrices, Matched Features

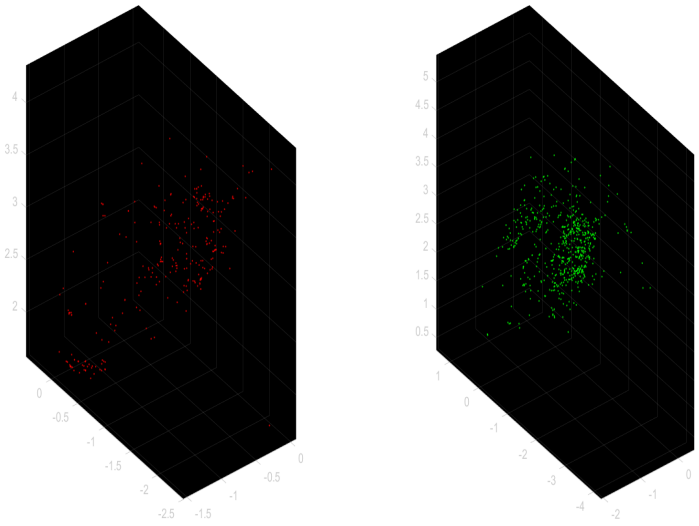

Figure 5: Spare Reconstruction Cameras 1,3 and 2,3

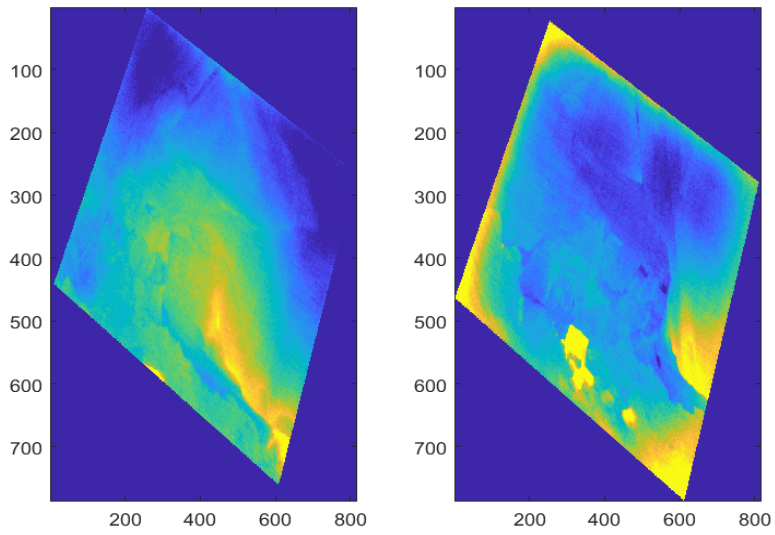

Figure 6: Rectified Image Pair 1,3

Bibliography

[1] https://biomech.web.unc.edu/wand-calibration-tools.