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Part 3: Bundle Adjustment

What a robust loss function such as Huber does and why we should use it here, but not in the calibration from sheet 2?

A loss function like Huber in Ceres reduces the influence of block with high residuals, usually cause in the case of outliers, i.e. samples that do not obey the noise model. In Bundle adjustment, we try to minimize the distance from feature corners (detected by keypoints detector) and corresponding 3D landmarks. Since matching feature pair, in this case, is not an exact algorithm, but an approximation, outliers can appear. In opposite, in Calibration, correspondences are almost exactly detected and there is no outlier since we use an AprilGrid with special characteristics (square boxes with QR code-like patterns). Therefore, we need a loss function as a regularizer for Bundle Adjustment but not in calibration.

Part 4: Outlier Filtering

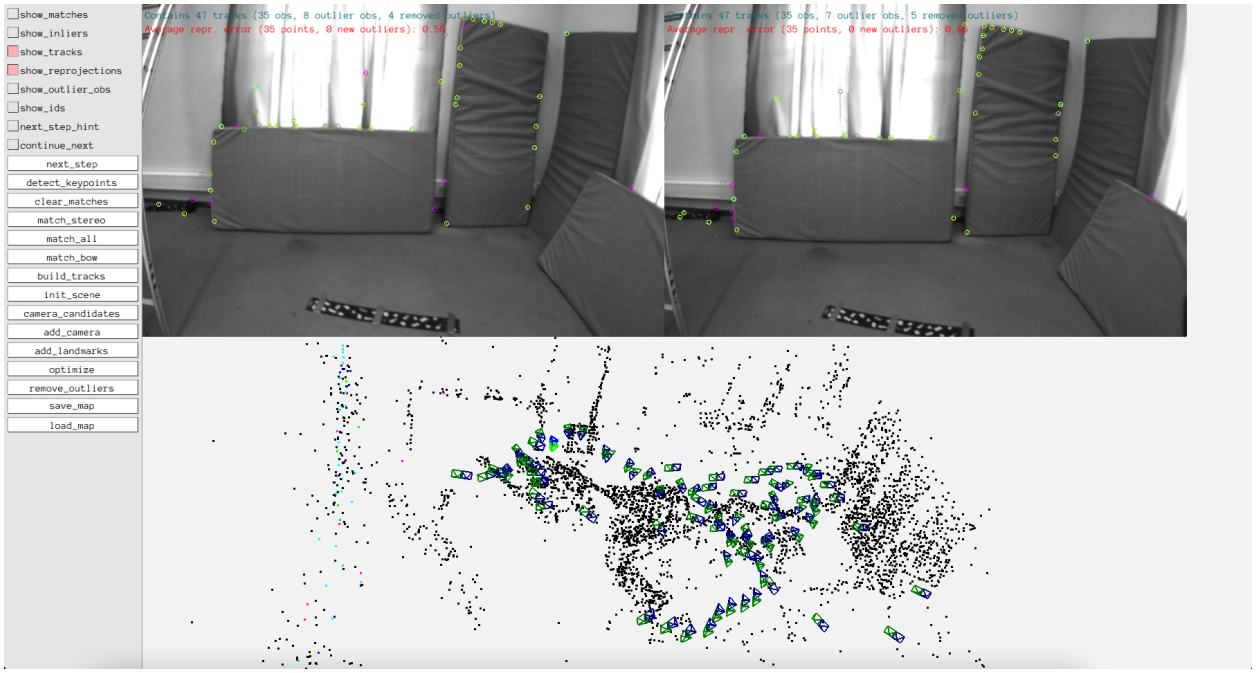
The different implemented criteria to detect outliers.

- Check for re-projection error, i.e. normalized distances between detected 2d corners with reprojection of 3d landmarks on images are larger than a set threshold.
- Check for landmarks that are too close to a camera center
- Check for landmarks with too small z coordinate for some camera

The two latter might correspond to outlier matches or points stuck in local minima.

Part 5: Building a Map

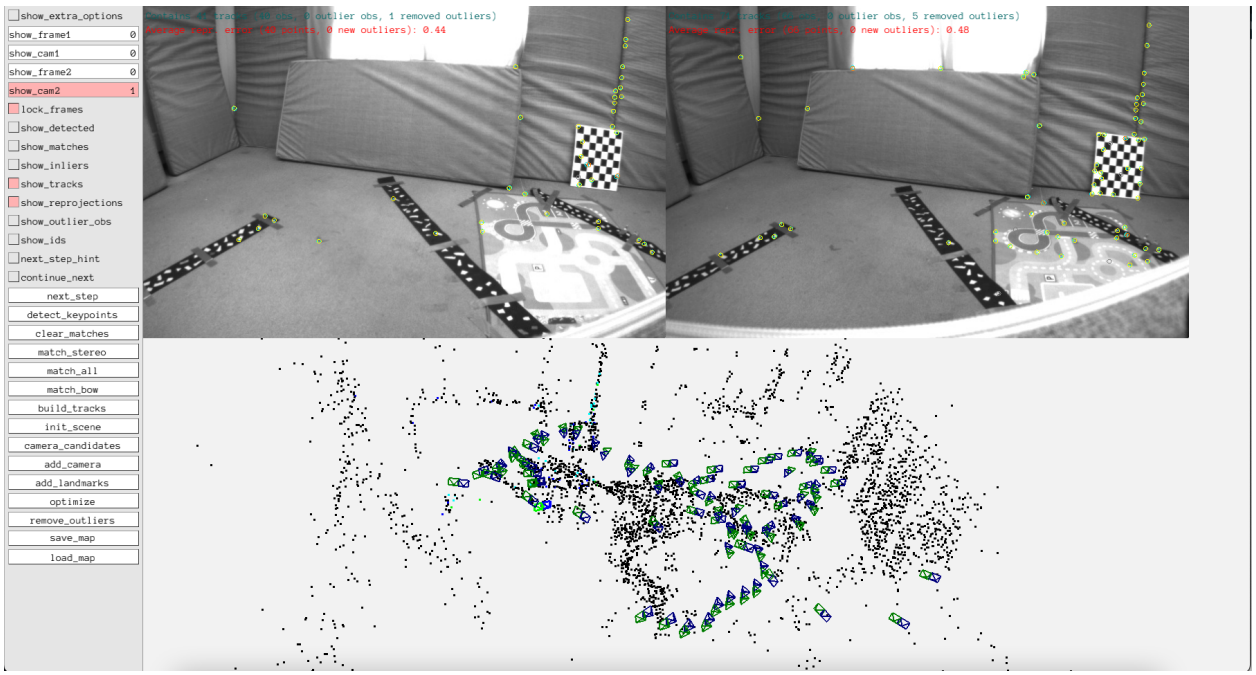
- Building a map with match all:



- The map has 164 cameras and 4760 landmarks with 24029 observations.

    - Total time: ~42 minutes on my machine.
    - Bundle Adjustment is the most time-consuming part.

- Do you have any suggestions on how to maybe speed up the map-building process?
    - If we can replace the Bundle adjustment of global params, i.e. all camera poses and all landmarks added to the map, with a faster process, i.e. feed cameras by timestamp and solve adjustment over n-previous frames, it would speed up the map building process.
- Building a Map with match bow:
    - The map has 157 cameras and 3994 landmarks with 19493 observations.
    - Total time: ~30 minutes
    - Bundle adjustment took the most time among all parts.



- `Match bow` had a shorter matching time and also shorter map-building time compared to match all. It seems like a trade-off since the map built with match bow also had fewer cameras than one with `match all` (157 vs. 164). It is possible that matching with a bag of word method missed some image pairs, which cause that. However overall results are not far behind match all, which suggests it is still a good method when prioritizing map building time.