

## Exercise 4

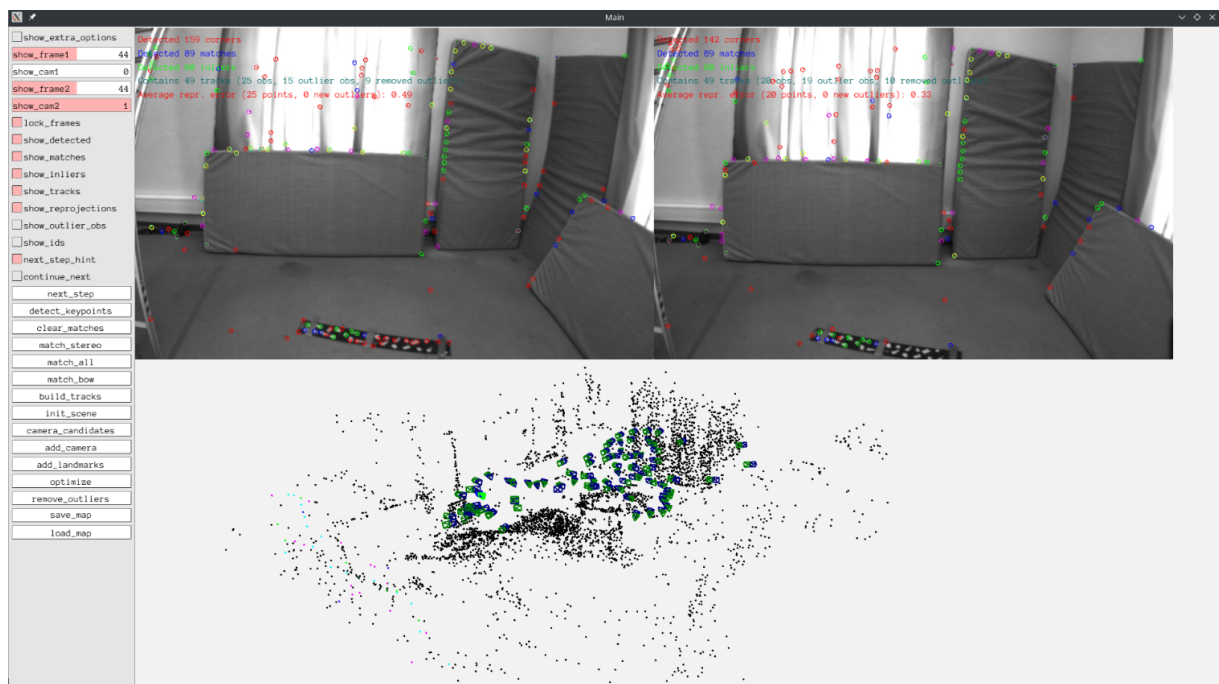
### Part 3

- A robust loss function adds another optimization goal which makes the system more robust to outliers. In calibration, there are no outliers, so we don't need to add an extra optimization goal which would increase computation unnecessarily.

### Part 4

- First we check if there are any outliers apart from the normal reprojection error. Four criteria are checked. The first one checks for too large reprojection error, second checks for large projection error, third one checks distance to the camera and the last one checks for too small z coordinate.
- Reprojection errors can happen when detected keypoints are wrongly matched. The more wrong the matches are, higher the reprojection error.
- For points too close to the camera, small movements will appear too large since the points are close which will make it hard to track it. Likewise for small Z coordinates. Also being too close to the camera will make it so that the camera might not be able to see the point properly from that angle.

### Part 5



- When used brute force matching 164 cameras are added to the map since there are 82 camera pair candidates in the beginning. The part that takes longest is the brute force matching, after which is the optimization part which is quite faster and the rest takes in around 40-50 seconds.
- Use more parallelization for the computations such as CUDA kernels or more OpenMP directives where possible in order to make it faster.
- With match bow the matching part is a lot faster, at each step there are many more outliers that are being ignored. The map had 158 cameras and 4078 landmarks with 19769 observations. 139 landmarks were removed as outliers and 1643 observations were marked as outliers.