Exercise Sheet 2

Topic: Camera Models, Optimization, Calibration

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Par1: Camera models

In the test/src/test ex2.cpp file, we generate test points $X = \{(x, y, 5) \in \mathbb{R}^3 | x = \{-10, -9, ..., 10\}, y = \{-10, -9, ..., 10\}\}$, so basically, $(10 + 1 + 10)^2 = 441$ test points in total.
We first normalize each test point (p) by using normalized() method in Eigen and assign it to variable named p_normalized. Then, we call the project() method with p as the argument to get the projected vector (res). Afterward, we use unproject() method with res which we get previously as its argument to get the test point back and assign it to variable p_uproj. Since we know from the paper [1] that the unprojected formula basically gives us a normalized vector, we compare p_normalized and p_uproj to see if they match.

Part 2: Optimization

The difference between curve fitting and robust curve fitting is the amount of data they use. Curve fitting fits a function with **all the data**. On the other hand, robust curve fitting fits a function with **all the "inlier" data**. The way it determines which one of them is an inlier or outlier is to set a threshold and if its loss is bigger than the threshold, it becomes an outlier. This could be quite useful when we have lots of outliers in our data (noisy) because we can ignore them and get a more robust result.

Part 3: Camera calibration

The command line parameters are:

1. –show-gui: Specify if the GUI is shown.
2. –dataset-path: Specify the dataset's directory.
3. –cam-model: Specify which camera model we are using.

For the quantitative evaluation, please refer to Table 1 and Figure 1, 2, 3, 4. It is not difficult to tell that the calibrated reprojected corners from Pinhole Model all have relatively big shifts from the ground true corners. This could also be confirmed by Table 1 since the final loss from Pinhole Model is still pretty high compared to the other models, which indicates that Pinhole Model might not be suited for the lenses that took these images.
For the other 3 models, it's really hard to tell the difference between each other because based on the figures, they almost perform equally well. If we have to choose the best among these 3, then KB4 might be slightly better than the other 2 according to its slightly lower final loss than those of the others.

	Pinhole	EUCM	KB4	DS
Final Loss	156573.5	162.7604	161.9844	162.7482

Table 1: Quantitative Evaluation of the Calibration of 4 Different Camera Models

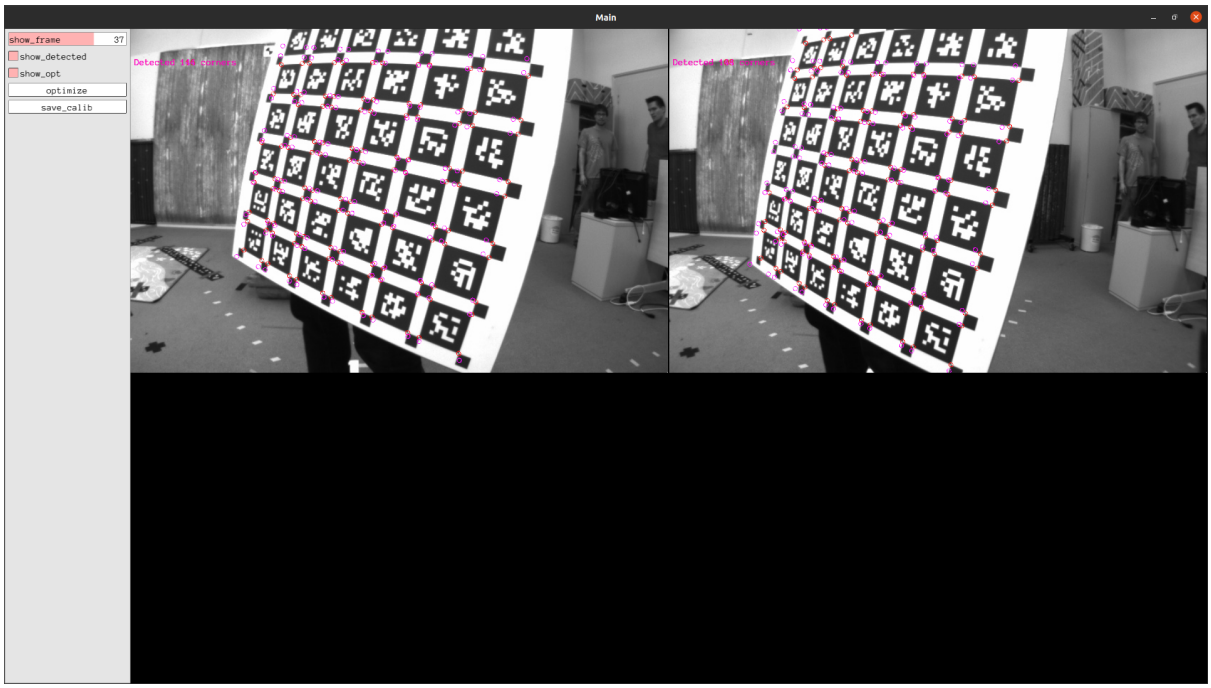

Figure 1: Calibrated Reprojected Corners from Pinhole Model

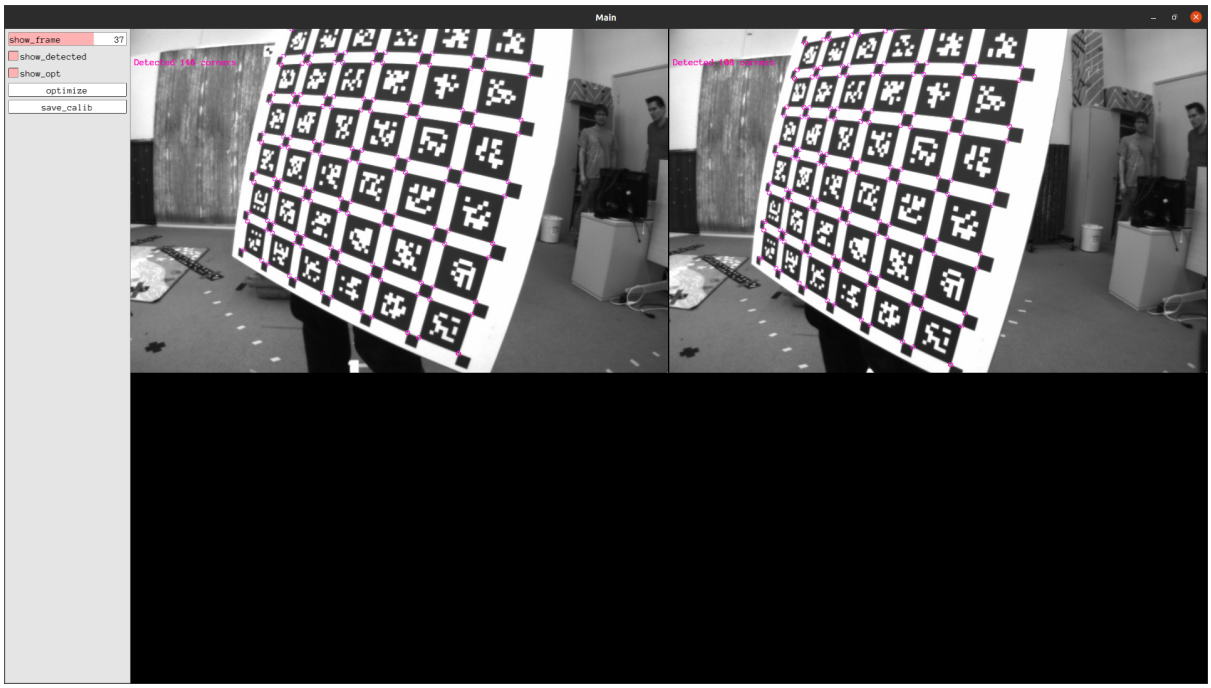

Figure 2: Calibrated Reprojected Corners from EUCM

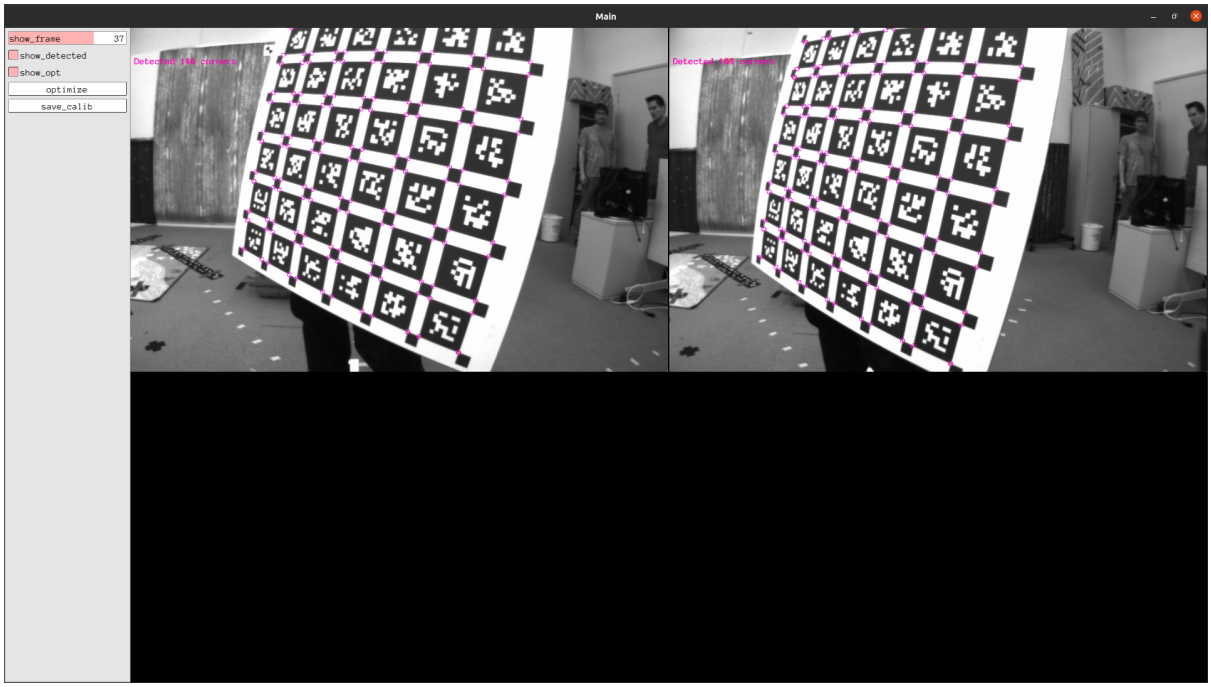

Figure 3: Calibrated Reprojected Corners from KB4

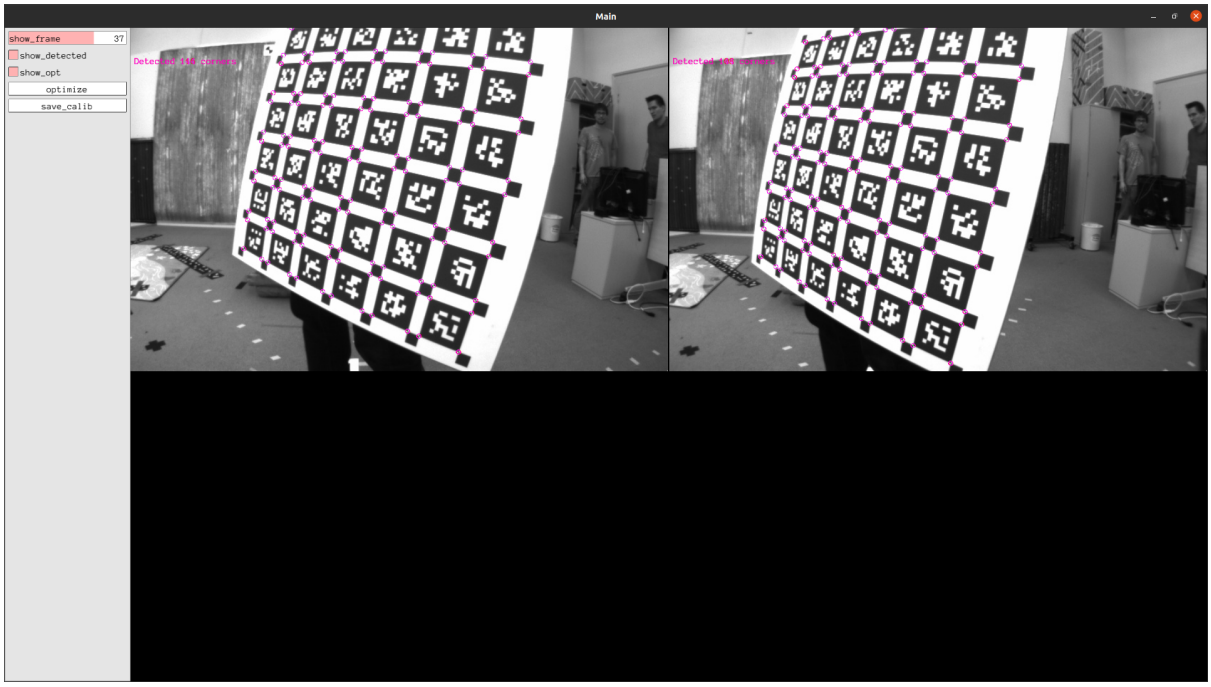

Figure 4: Calibrated Reprojected Corners from DS

References

[1] V. Usenko, N. Demmel, and D. Cremers, "The double sphere camera model," in *Proc. of the Int. Conference on 3D Vision (3DV)*, September 2018.