

Vision-based Navigation Exercise 2

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1 Part 1

The test file loops over the 3D points in the interval $[(-10,10,5),(10,10,5)]$ and normalizes the points and projects the points into 2D, then unprojects it using the given method. If the implementation of the camera models is correct, then normalized point and unprojected point must be the same. The assertion checks this property, and there are 4 tests which cover all 4 covered camera models.

2 Part 2

First example fits the curve directly into the given data points and is affected by the outliers. On the other hand, second implementation demonstrates the loss functions in Ceres which can filter out the outliers in the data and produce more accurate results.

3 Part 3

Calibration code uses 3 command line parameters:

- `-show-gui`: It is a boolean and true by default. It controls the display of GUI. If set to 0, then no GUI appears.
- `-dataset-path`: Sets the path to the dataset, there is no default value, hence it is required for the executable to run.
- `-cam-model`: Sets which camera model to be used for the program. Default value is "ds", double sphere camera model. Other options are "pinhole" (pinhole camera model), "eucm" (extended unified camera model), "kb4" (Kannala-Brandt camera model).

After inspecting the behaviour of the program with all the camera models, I've observed the following: Pinhole model performs the worst and it not able to align corners properly, there is visible difference. This happens because camera has a large field of view, which contradicts with the definition of its projection function. (They have defined it such that z value is always greater than 0 in

front of the camera. Other three models performed similarly and all were able to get correct results. One quantitative value to compare different camera models is the mean reprojection error mentioned in the paper. I've also observed that the pinhole model produces a much larger initial error compared to the other three methods. The initial reprojection errors are as follows:

- DS: 5.353182e+06
- EUCM: 5.353182e+06
- KB4: 5.788049e+06
- Pinhole: 1.795667e+07