

**Project #1**

Due time: Monday, Feb 18<sup>th</sup>, before class starts

**Part 1: Camera calibration using linear method (50pts)**

- Implement the conventional camera calibration method introduced in class – estimating camera parameters from the projection matrix using 2D-3D correspondence either in c++ or matlab.
- Perform experiments on a given data set and estimate the calibration performance in terms of projection error. You may only use part of the data for calibration, and the remaining data for error analysis. The projection error can be defined as

$$\varepsilon = \frac{1}{N} \sum_{i=1}^N \|m_i - \hat{m}_i\|$$

where N is the number of points for error analysis.  $m_i$  is the ground truth (given) image point and  $\hat{m}_i$  is the estimated image point by projection.

**Part 2: Robust camera calibration (50pts)**

As introduced in class, we can use the RANSAC method when there are outliers in the data.

- Implement the RANSAC method and perform experiments on the given data set and estimate the calibration performance in terms of projection error.
- You can assume the whole data set may contain up to 20% outliers.

**Bonus question: (10 pts)**

We have shown in class that the projection matrix can be estimated as a solution to  $\mathbf{A}\mathbf{v} = 0$ . When  $\text{rank}(\mathbf{A}) = 11$ ,  $\mathbf{v}$  can be estimated by performing SVD on  $\mathbf{A} = \mathbf{U}\mathbf{D}\mathbf{V}^T$ . Prove that  $\mathbf{v}$  is the last column of the  $\mathbf{V}$  matrix with an unknown scalar.

**Requirement:** you need to submit your project as a **SINGLE zipped file named as Lastname-Firstname-Proj1** through department dropbox (dropbox.cse.sc.edu) including

1. A written project report includes a brief introduction on the addressed problem, a succinct description on the methods you implemented with the major steps, the experimental results and analysis, conclusion, and reference.

Note: the experimental results must include

- The experimental setting, e.g., the number of points used for calibration, and the number of iterations used in RANSAC

- The estimated camera parameters
- The calibration performance in terms of projection error

For analysis, you may consider what happen if you change the experimental settings.

2. Code with appropriate comments.