Project Parameter Estimation (PPE), 2020 HS
Block 1 „Scanner Calibration“
Assignment 1, September 18, 2020

Background

Laser scanner measurements are affected by several imperfections of the instrument (scale factor deviations, axis misalignments, offsets, etc.). In order to fully exploit the potential accuracy of the instruments, these imperfections are modeled mathematically and mitigated by calculating corrections of the raw data. The process of estimating appropriate numeric values of the parameters of these models is called laser scanner calibration.

Within this block of PPE you will develop and implement an algorithm for terrestrial laser scanner calibration. You will work in groups of 2-3 students. You will start from a scientific paper, understand the problem, make choices regarding implementation in MATLAB, and carry out that implementation. You will use the implementation to process measurement data which will be given to you. Finally, you will critically assess the results and identify strengths and weaknesses both of the given approach (as of the scientific paper) and of your implementation.

Tasks

The following tasks are to be accomplished individually (no group work) within assignment 1 of this block:

1. Read and comment Lichti (2007), as uploaded for you on nb.mit.edu (register using the link obtained by email). Ask questions and insert comments regarding parts of the paper you do not understand, you consider wrong, or you deem particularly important. Answer questions which other students have posted, or vote for their questions to indicate that you also wonder.

   Thoughtful posts (including questions, remarks, and answers) will be awarded with points towards the maximum of 30 for this entire block (see below).

   The purpose of the reading is to understand (i) the specific scanner error model proposed within this paper, and (ii) scanner calibration within a point field in general. Careful reading should prepare you for discussion of calibration and implementation options in class, next week.

   Due: September 24, 2020, 18:00

2. Refresh your working knowledge of parameter estimation based on the least-squares principle within (a) the Gauss-Markov model (GMM) and (b) the Gauss-Helmert model (GHM). You should be able to reproduce and explain the main concepts and equations of both (model equations, calculation of parameters). Chose appropriate sources on parameter estimation / adjustment theory and bring them or notes as needed to class on September 27. Knowledge of these models will be awarded with points towards the grade of the course (see below).

3. Prepare a printout of the paper or bring a mobile computer with the pdf to the next class. You will need the paper for work in class.

Next class

On September 25 we will (i) discuss the paper and your comments in nb, (ii) discuss concrete calibration needs to be fulfilled within this block of the project (the requirements will differ slightly from those in the paper, so you will have to modify the approach described in the paper), (iii) discuss the pros and cons of estimation within GMM or GHM for this application, (iv) decide on a model for implementation. Starting with (iii) you will work in small groups (2-3 students). The discussion of pros and cons of estimation within GMM and GHM will be based on a brief questionnaire regarding these two adjustment models which you fill in as a group and present to the entire class afterwards.

Grading of this block

A maximum of 30 points can be obtained for your contributions within this block. They are then used to calculate the overall grade of the course as outlined in the course introduction.

The total points for this block result from the following contributions[1]:

a.	Thoughtful personal contributions to the online discussion indicating careful reading of the paper Lichti (2007):	max 5 points
b.	Thoughtful personal contributions to the in-class discussion of the paper, and correct answers to the questionnaire on GMM/GHM (group work, textbooks & notes admitted):	max 5 points
c.	Thoughtful personal contributions to in-class discussion on Oct 16 indicating careful reading of paper Krarup (1980):	max 5 points
d.	Readability (formatting, variable names, comments), proper functioning (no crashes due to syntax errors or unknown commands, …) and documentation (help information including at start of files for getting started) of Matlab code (group work):	max 5 points
e.	Correctness and completeness of numerical results (group work):	max 5 points
f.	Quality of written report (focus, correctness, completeness, readability; group work):	max 5 points
g.	Bonus for thoughtful personal contributions to discussions and problem solving on Oct 2 and during presentation of results on Oct 30	max 4 points

[1] Including bonus points, no more than 30 points will be awarded for this block.