Lab 2
Sensor Calibration using TerraMatch
LiDAR Systems & Processing,
Centre of Geographic Sciences, NSCC

Overview

For your second lab you will be using the *TerraMatch* software package to analyze and correct LiDAR data for angular misalignments between the laser head and the IMU (called *boresight* calibration).

Using LiDAR data collected over the town of Middleton you will work through importing & editing trajectory data (i.e. GPS & IMU output), analyzing point clouds for roll, pitch and heading boresight errors, matching flightline points to determine adjustments and finally applying those adjustments to the entire project data.

As before, a guide performing these tasks has been included with this lab. This guide should be used in combination with those from the first lab to perform all of the necessary tasks for this project.

Project Data

The various datasets (see table below) for this project can be retrieved from the following folder. Note that there are several sub-folders; copy **all of the folders and their contents** into the **`D:\middleton`** folder on your hard drive.

`\\nas\RS\REMS_6085\Assignments\Lab2`

The `D:\middleton` folder is **required** since absolute file pathnames are stored within TerraScan project files. Using a simple & consistent folder for the project will reduce file management headaches.

Filename	Description
`las`	Contains LAS files for 9 flightlines covering a portion of the town of Middleton. (1)
`reference\middleton_study_area.dgn`	A polygon delineating the area to focus on for creating your TerraScan project and LiDAR blocks. (1)
`trajectory\sbet_01.out`	GPS & IMU output from POSPac (Applanix software).

(1) Provided data uses the UTM 20 NAD83 CSRS98 coordinate system (SBET data is in Geographic NAD83 CSRS98).

LiDAR Data

The LiDAR points provided with this lab were acquired by the Applied Geomatics Research Group (AGRG) on Julian Day 332, 2007. While the full survey consists of several hundred tiles, only a subset of this survey has been provided. This subset was selected as it provides a clear example of sensor mis-alignment while remaining relatively easy and quick to correct.

The points have been processed from their original raw format (i.e. laser ranges, IMU/GPS, etc.) into LAS point files (via Optech's DashMap software package). Note that there are several LAS files in the `las` folder; each is associated with a single flightline flown during the survey.

SBET (Smoothed Best Estimate of Trajectory)

The GPS and IMU data from the LiDAR system is typically processed into a smoothed best estimate of trajectory (SBET) that represents the path that the aircraft flew during the LiDAR survey. While this data can be provided in a variety of formats, the most common is the "raw" SBET format typically output by the GPS/IMU processing software (e.g. Applanix POSPac in this case).

Project Requirements

Project Preparation

The first step for this project is to create a TerraScan project similar to the one created in the first lab. Use the provided study area polygon to create your project blocks (1 km in size, and non-overlapping) and then import the flightline LAS files. When you are confident that you have your project set up correctly (i.e. all data has been correctly imported into the `blocks` folder), and have imported the LAS flightlines, you may delete the `las` directory and its contents to reduce the storage requirements for this project.

Data Correction

Once a project has been prepared, use *TerraScan Guide 3* as a reference to perform the following tasks:

- Import trajectory data (SBET) and define flightlines
- Assign flightline numbers to project points
- Analyze point data to determine types & extent of sensor boresight errors
- Create a calibration dataset for TerraMatch
- Use TerraMatch to analyze & correct point data
    - boresight calibration (heading, pitch & roll)
    - adjustment of individual flightlines (z-shift)

During your processing, be sure to save the various reports and outputs as stated in the guide (a table of all reports is provided on the next page). These reports can be an important reference when something goes wrong.

Deliverables

Questions

Answer all questions in the *Lab2-Questions* document that is posted on Brightspace.

Digital Products

In addition to the written report, please submit a digital copy of your products to the folder stated below. Your submission should be **comprehensive & self-contained**, meaning that all of the data required to re-produce your results should be included (i.e. in case of errors and/or updates).

Be sure that your digital submission includes the following files. As a guide for data organization, please consider the following tables for folder structure and filename conventions.

Remember that all files were to be placed under the folder `D:\middleton` since TerraScan stores absolute filenames. If this was not done, please reset your folder settings within the TerraScan *Project* window (*Edit project information* under the *File* menu) before submission. Zip all of this data into a compressed folder named **YourSurname_Lab2.zip** and post to the RS drive in the directory specified below.

Filename	Description
middleton.prj	TerraScan project file for your "survey" blocks.
middleton_calibration.prj	TerraScan project file for your "calibration" blocks.
middleton.dgn	Microstation DGN file
YourSurname_Lab2_report.pdf	Digital copy of your report (as PDF).
Sub-Folders	**Description**
blocks	Corrected, re-imported project blocks & z-shifted blocks
blocks_corrected	Corrected project blocks (boresight applied)
blocks_original	Original blocks for back up
calibration	Calibration dataset (prepared for TerraMatch)
calibration_corrected	Corrected calibration blocks (boresight applied)
reference	Reference data (e.g. study area polygon)
reports	Various reports produced during processing (see below)
macros	Various macros required for processing (see below)
trajectory	SBET & derived trajectory (.trj) files
"macros" Folder	**Description**
deduce_flightlines.mac	Identify flightline numbers for each LiDAR point
classify_grdbyflightline.mac	Prepare points for TerraMatch analysis
"reports" Folder	**Description**
survey_import_points.txt	Importing flightline LAS files into survey project.
deduce_flightlines.txt	Assigned flightlines & points left unassigned
calibration_classify.txt	Results of per-flightline classification of calibration blocks.
calibration_starting.txt	Measure Match results of uncorrected calibration blocks.
calibration_match.txt	Find Match results (RMS & adjustments)
calibration_match.tms	Corrections from Find Match
calibration_final.txt	Measure Match results of corrected calibration blocks
survey_classify.txt	Results of per-flightline classification of survey blocks.
survey_starting.txt	Measure Match results of uncorrected survey blocks.
survey_corrections.txt	Apply Corrections results for entire survey project.
survey_final.txt	Measure Match results of corrected survey blocks.
survey_reimport.txt	Re-imported points after correction
survey_zshift.txt	Find Match (Z-Shift only) results of survey blocks
survey_zshift_final.txt	Measure Match results of z-shifted survey blocks.

Evaluation

The evaluation criteria for this project will be based upon:

Description	Value
Questions	30%
Digital deliverables (organization, adherence to specifications, project, DGN prep., flightline delineation, calibration dataset, data correction, adjustments, required files, etc.)	70%

This assignment is worth 30% of your *REMS 6085* mark.

Due: Tuesday, February 18th, 2020 @ 8:00AM.