Data Quality Report - 2015
LiDAR

ARSF - Data Analysis Node

Updated on: September 7, 2015

Contents

1 Overview

This report describes issues that may affect the quality of your LiDAR dataset and what should be considered for further processing of your dataset. It is anticipated that the document will be updated throughout the year, the latest version of which will be available at:

http://arsf-dan.nerc.ac.uk/trac/wiki/Reports

2 Geo-referencing accuracy

Currently, the ARSF delivers LiDAR datasets in both ASCII and LAS point cloud format, with separate files per flight line. Prior to delivery, each flight line is compared to its neighbouring lines to compare respective elevation in overlapping regions and also horizontal planar shifts. For UK flights where vectors are available, we compare the horizontal planar accuracy to these vectors.

If ground control points (GCPs) are available for the region then we will use these as a control to correct for possible elevation errors in the LiDAR data. If no GCPs or accurate ground truth are available then no height correction will be applied, but an average per-line elevation difference for the overlapping region may be included within the readme file of your delivery.

3 Roll Boresight Error

Unfortunately there is an issue with the roll boresight angle such that it varies between flight lines flown at different heights. This error has been present since February 2009. No definite trend in the variations is apparent at the moment but the roll boresight value does differ between flight lines collected on the same day.

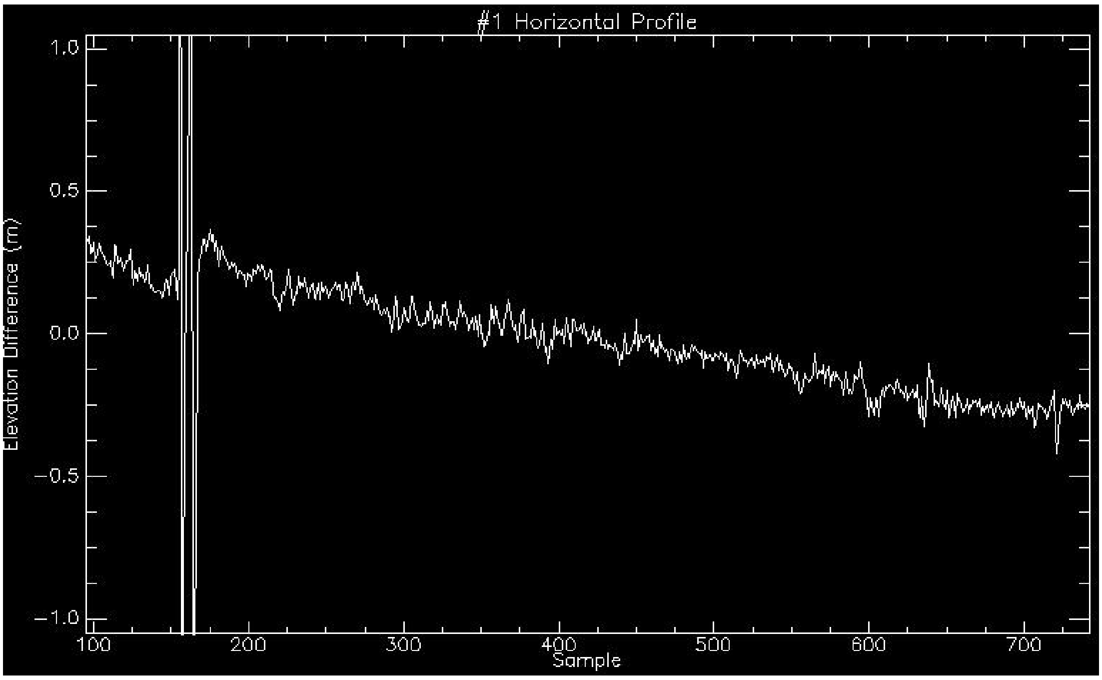

Figure 1: *Elevation difference between two point clouds from opposing flight lines flown at 2000m altitude, showing an across track slope. Note large spikes are due to hedge rows.*

Figure 1 shows the elevation difference between two point clouds from opposing flight lines flown at 2000m altitude. The difference should be flat and close to zero but a slope across track is clearly visible with a magnitude of approximately 55cm change across the swath.

The current protocol for dealing with this issue in the data is to manually boresight using the overlapping areas between different point clouds as a guide, iteratively processing until there are no relative trends between the neighbouring point clouds.

If there are no areas of overlap between neighbouring flight lines then this issue can not currently be corrected for and an unknown roll error will remain in the dataset.

This issue has been found to be present in other Leica Geosystems LiDAR sensors and is not system specific. The source of this systematic bias is currently under investigation by Leica Geosystems.

4 Pitch Boresight Error

Since September 2012 an issue has been identified in some data sets suggesting there may be an error with the pitch boresight, which changes per data set. No definite trend in the variations is apparent at the moment but the pitch boresight value does differ between flights collected on the same day.

The current protocol for dealing with this issue in the data, where the issue is dramatic enough to be measured, as in this case, is to manually boresight using the overlapping areas between different point clouds as a guide, iteratively processing until projections of features on the ground appear to have identical positioning.

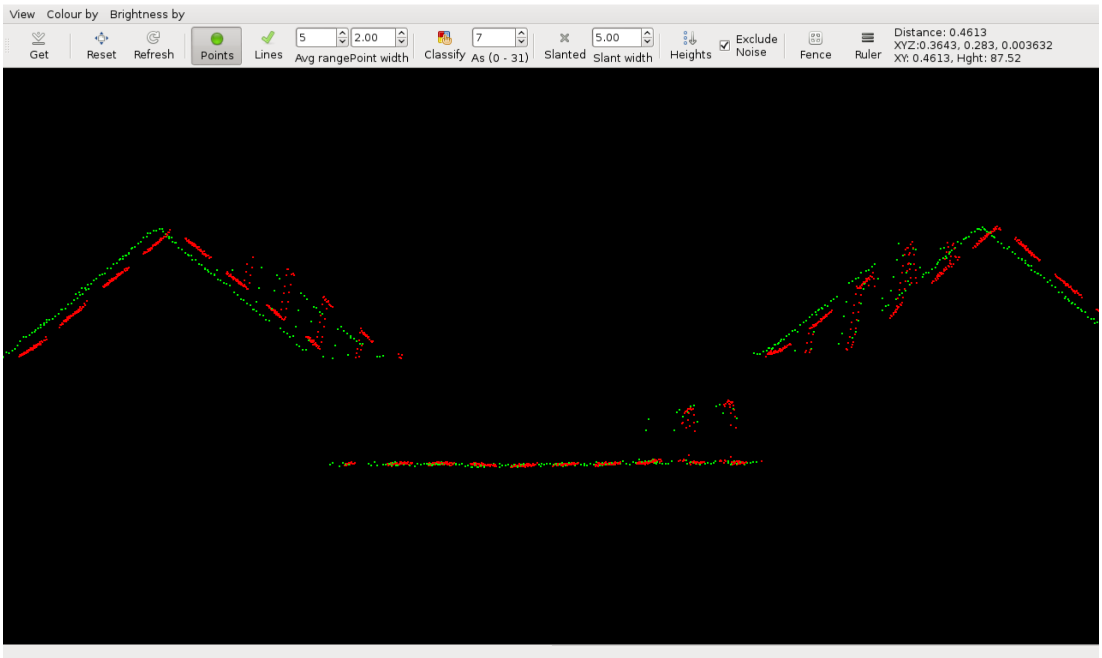

Figure 2: *Horizontal difference is demonstrated most dramatically in the cross sections of rooftops along the length of two opposing flightlines. Points in the right-most projection are collected from a flightline headed south-west, while points in the left-most projection are from a directly opposite, north-east bound, flightline.*

Figure 2 shows the horizontal difference between two point clouds from opposing flightlines flown at 1500m altitude. The projections of each roof should be lined up as much as possible, but the difference in horizontal positioning between features could be up to the order of 50cm.

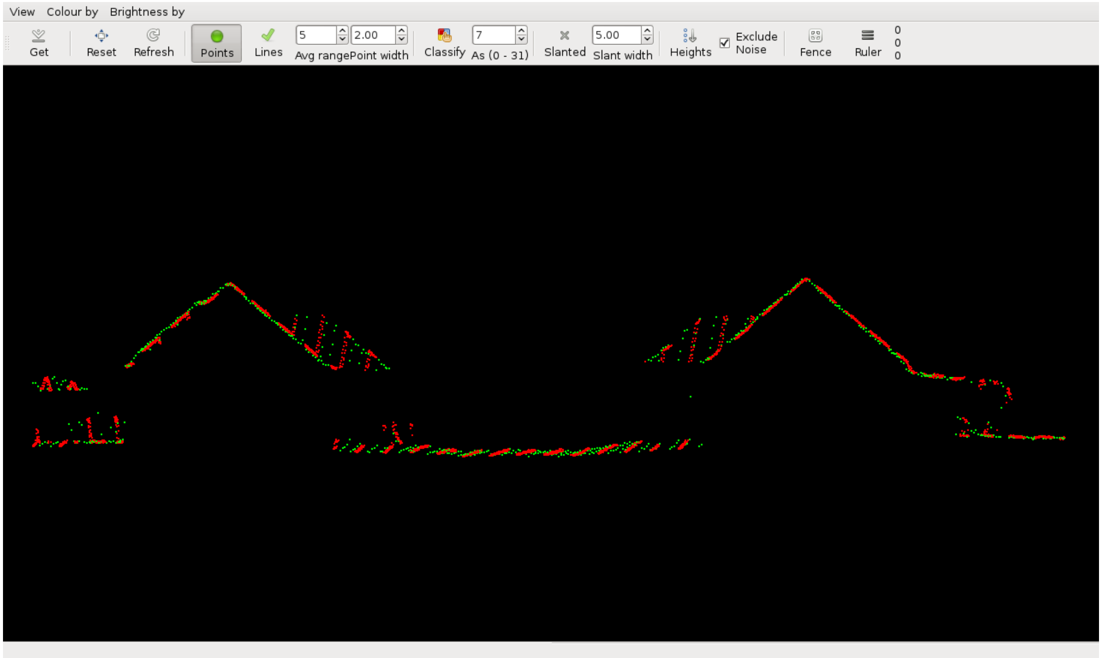

Figure 3: *The same features as in Figure 2 after pitch correction has been applied. Note the small misalignment still present.*

If there are no areas of overlap between neighbouring flight lines then this issue can not currently be corrected for and an unknown pitch error will remain in the dataset.

5 Data Accuracy

A calibration flight is performed each time the sensor is removed from the aircraft for maintenance or system updates.

For each calibration the accuracy of the LiDAR elevation has been compared to ground control points (GCP) using available software (LASControl). This creates a Triangulated Irregular Network (TIN) of points near to the GCP and then compares the GCP against the surface elevation. A short summary of the results of each calibration is given below.

5.1 Flights April 2015 onwards

The data collected from Little Rissington, together with the GCP data, was then used to range correct the LiDAR. The comparison between LiDAR and

GCPs gives:

- Mean error magnitude of 3.2cm with a standard deviation of 3.0cm for the 750m altitude data.
- Mean error magnitude of 5.8cm with a standard deviation of 4.6cm for the 1350m altitude data.
- Mean error magnitude of 2.4cm with a standard deviation of 2.3cm for the 2500m altitude data.

5.2 Flights July 2015 onwards

The data collected from Little Rissington, together with the GCP data, was then used to range correct the LiDAR. The comparison between LiDAR and GCPs gives:

- Mean error magnitude of 4.1cm with a standard deviation of 4.8cm for the 750m altitude data.
- Mean error magnitude of 4.3cm with a standard deviation of 5.9cm for the 1350m altitude data.
- Mean error magnitude of 4.9cm with a standard deviation of 6.2cm for the 2500m altitude data.

6 Classification

We run a basic classification routine on all processed data to highlight any noisy points. This includes low points appearing below the ground, high points that may be due to haze and isolated points due to systematic noise. We do quality check the data, however we do not perform rigorous verification of the classification. As a result some erroneous points may remain in your data.

In your delivery points deemed to be noise will have classification of 7 whilst all other points will have a classification of 1, following the ASPRS standards on LiDAR classification.

We do not remove noisy points in case, for your studies, they are points of interest. However, a program included with your delivery can be used to create new point cloud files which only contain points of certain classifications.

7 Digital Elevation Model (DEM)

In most cases we will generate a DEM during the processing of your LiDAR dataset which can be used to aid the processing of the Specim hyperspectral data. If this is the case it will be included with your delivery with a description of the DEM in the readme file (including pixel resolution, datum information and a description of the header format).

Your hyperspectral data coverage may extend further than your LiDAR data. Where possible we will patch external DEM data to your LiDAR DEM. Please see the readme included with your delivery for specific information relating to your project.

If you wish create your own DEM from your LiDAR data please see our notes at:
http://arsf-dan.nerc.ac.uk/trac/wiki/Help/LeicaLidarDems