LiDAR Data QA/QC Report

Louisa, VA
Originally submitted: Monday, April 20, 2012

Submitted by:

LMSI

Executive Summary

This LiDAR project was to provide high accuracy, calibrated multiple return LiDAR for the Louisa, VA area. Data was collected and delivered in compliance with the “U.S. Geological Survey National Geospatial Program Base LiDAR Specifications, Version 13 – ILMF 2010”.

The elevation data was verified internally prior to delivery to ensure it met fundamental accuracy requirements (vertical accuracy NSSDA RMSEZ = 12.5cm (NSSDA AccuracyZ 95% = 24.5 cm) or better; in open, non-vegetated terrain) when compared to static and kinematicGPS checkpoints. Below is the summary for the test:

- The Louisa LiDAR dataset was tested to 0.035m vertical accuracy at 95% confidence level based on consolidated $RMSE_z$ (0.018m x 1.960) when compared to 11 GPS static check points.

All data delivered meets or exceeds LMSI’s deliverable product requirements.

LMSI.. 1
Executive Summary.. 2
Introduction.. 4
1. LiDAR Data Processing.. 5
1.1.Airborne GPS Kinematic.. 5
1.2.Generation and Calibration of Laser Points (raw data).. 5
2. Quality Control for Data Processing LiDAR.. 6
2.1.Calibration Setup and Data Inventory.. 6
2.2.Boresight and Relative accuracy.. 6
2.3.Absolute accuracy.. 6
3. Conclusion.. 7

Introduction

LiDAR data is remotely sensed high-resolution elevation data collected by an airborne collection platform. By positioning laser range finding with the use of 1 second GPS with 200 Hz inertial measurement unit corrections; LMSI's LiDAR instruments are able to make highly detailed geospatial elevation products of the ground, man-made structures and vegetation.

The purpose of this LiDAR data was to produce high accuracy 3D terrain geospatial products for flood mapping and other applications.

This report covers the LiDAR processing methods and calibration techniques.

Please note that this report focuses solely on the LMSI activities pertaining to the LiDAR data processing and calibration component of this project.

1. LiDAR Data Processing

1.1. Airborne GPS Kinematic

Airborne GPS data was processed using the PosPac kinematic On-The-Fly (OTF) software suite. Flights were flown with a minimum of 6 satellites in view (13° above the horizon) and with a PDOP of better than 4. Distances from base station to aircraft were kept to a maximum of 40km.

For all flights, the GPS data can be classified as excellent, with GPS residuals of 3cm average or better but no larger than 10cm being recorded.

GPS processing reports for each mission are included as an appendix.

1.2. Generation and Calibration of Laser Points (raw data)

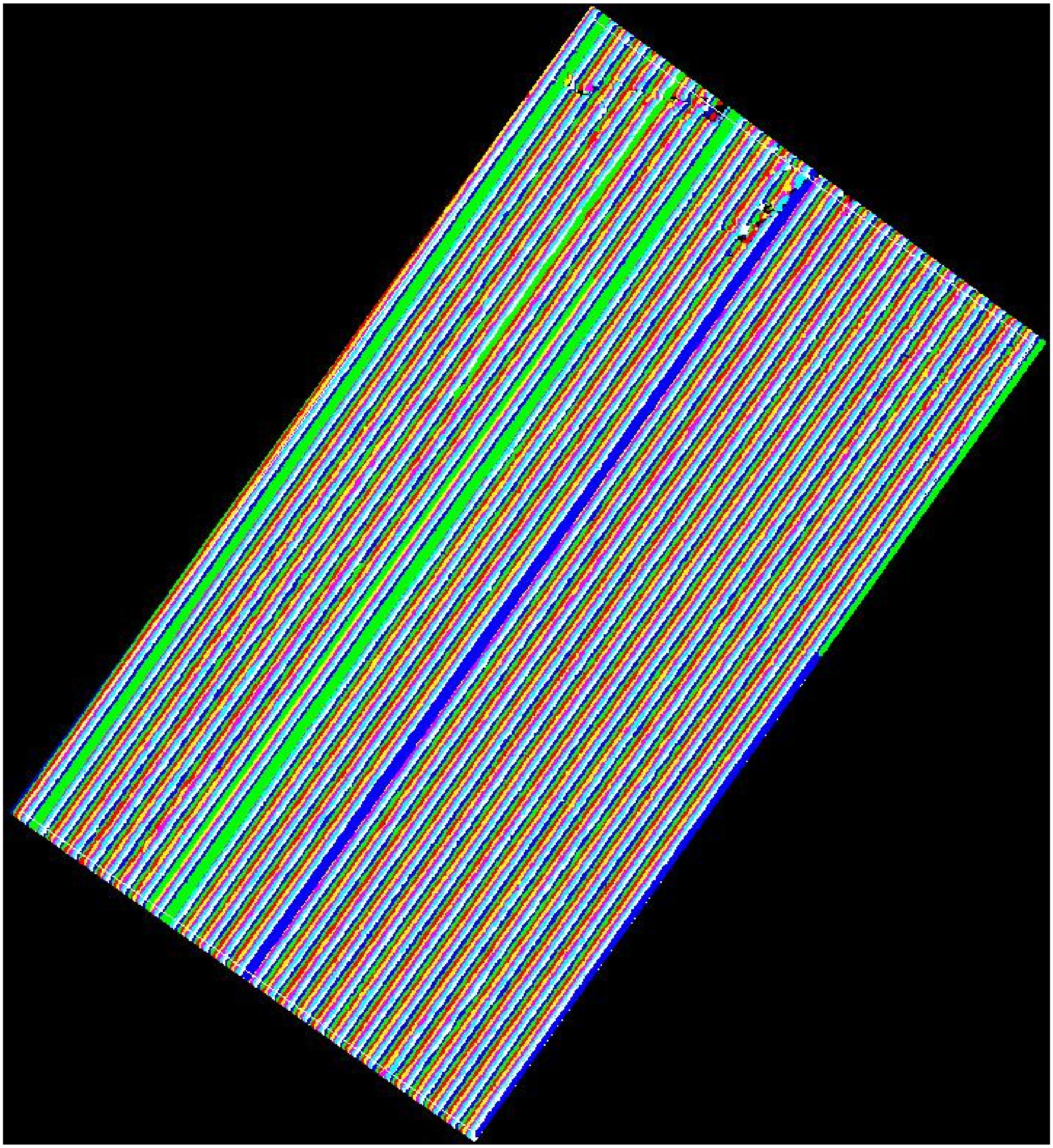
The initial step of calibration is to verify availability and status of all needed GPS and Laser data against field notes and compile any data if not complete.

Subsequently the mission points are output using Optech's Dashmap, initially with default values from Optech or the last mission calibrated for system. The initial point generation for each mission calibration is verified within Microstation/Terrascan for calibration errors. If a calibration error greater than specification is observed within the mission, the roll pitch and scanner scale corrections that need to be applied are calculated. The missions with the new calibration values are regenerated and validated internally once again to ensure quality.

All missions are validated against the adjoining missions for relative vertical biases and collected GPS validation points for absolute vertical accuracy purposes.

On a project level, a supplementary coverage check is carried out to ensure no data voids unreported by Field Operations are present.

Louisa swath output showing complete coverage



A final calibration is performed in the office using Terramatch, and a control report is ran to compare the data to static GPS control points to ensure accuracy. The following are the final GPS static control reports:

Static GPS Validation

X:\projects\Louisa\control\static-new.txt

Number	Easting	Northing	Known Z	Laser Z	Dz
10	779082.100	4208915.140	106.870	106.870	+0.000
5	771486.430	4211451.540	143.380	143.420	+0.040
6	767707.320	4203490.850	116.930	116.920	-0.010
8	783074.730	4213618.480	83.800	83.770	-0.030
9	776313.090	4219276.100	111.700	111.700	+0.000
1	765400.570	4192747.620	122.800	122.780	-0.020
2	775267.650	4203147.160	113.130	113.140	+0.010
3	766826.880	4209601.820	142.670	142.670	+0.000
111	766468.650	4211361.270	148.760	slope	*
21	765722.840	4211225.710	144.810	144.810	+0.000
222	765379.130	4211178.860	142.420	142.420	+0.000

Average dz	-0.001
Minimum dz	-0.030
Maximum dz	+0.040
Average magnitude	0.011
Root mean square	0.018
Std deviation	0.019

2. Quality Control for Data Processing LiDAR Calibration

Quality assurance and quality control procedures for the raw LiDAR data are performed in an iterative fashion through the entire data processing cycle.

The following list provides a step-by-step explanation of the process used by LMSI to review the data prior to customer delivery.

2.1. Calibration Setup and Data Inventory

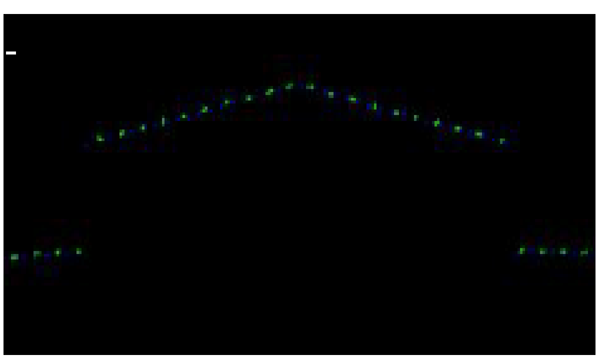
Data collected by the LiDAR unit is reviewed for completeness, acceptable density and to make sure all data is captured without errors or corrupted values. In addition, all GPS, aircraft trajectory, mission information, and ground control files are reviewed and logged into a database.

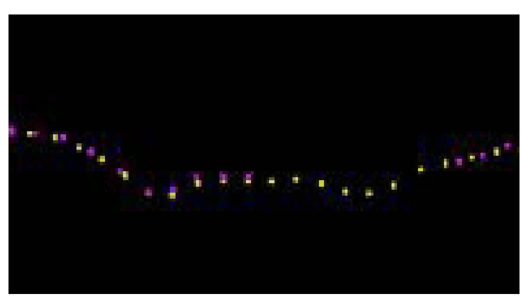
2.2. Boresight and Relative accuracy

The initial points for each mission calibration are inspected for flight line errors, flight line overlap, slivers or gaps in the data, point data minimums, or issues with the LiDAR unit or GPS. Roll, pitch and scanner scale are optimized during the calibration process until the relative accuracy is met.

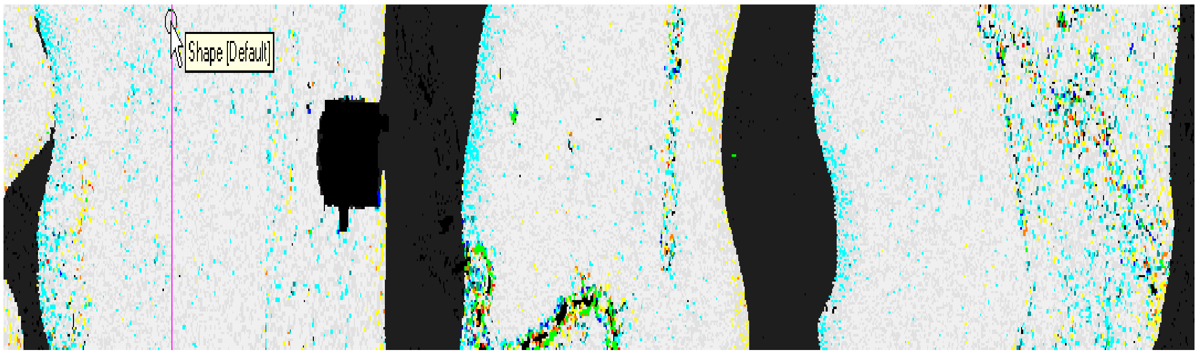
Relative accuracy and internal quality are checked using at least 3 regularly spaced QC blocks in which points from all lines are loaded and inspected. Vertical differences between ground surfaces of each line are displayed. Color scale is adjusted so that errors greater than the specifications are flagged. Cross sections are visually inspected across each block to validate point to point, flightline to flightline and mission to mission agreement.

For this project the specifications used are as follow:
Relative accuracy <= 7cm RMSEZ within individual swaths and <=10 cm RMSEZ or within swath overlap (between adjacent swaths) .

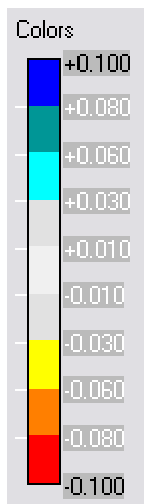




Profile views showing correct roll and pitch adjustments.



QC block colored by distance to ensure accuracy at swath edges.



A different set of QC blocks are generated for final review after all transformations have been applied.

2.3. Absolute accuracy

A preliminary $RMSE_z$ error check is performed at this stage of the project life cycle in the raw LiDAR dataset against GPS static and kinematic data and compared to $RMSE_z$ project specifications. The LiDAR data is examined in open, flat areas away from breaks. Lidar ground points for each flightline generated by an automatic classification routine are used.

Results:

Prior to delivery the elevation data was verified internally to ensure it met fundamental accuracy requirements of 18.5cm vertical accuracy at the 95% confidence level (2 sigma = RMSE * 1.96) in when compared to LMSI kinematic and static GPS checkpoints.

Data is compiled to meet 1m horizontal accuracy at the 95% confidence level (2 sigma = RMSE * 1.96)

- The LiDAR dataset was tested to 0.035m vertical accuracy at 95% confidence level based on consolidated $RMSE_z$ (0.018m x 1.960) when compared to 11 GPS static check points.

3. Conclusion

Overall the LiDAR data products collected LMSI meet or exceed the requirements set out in the Statement of Work for this project. The quality control requirements of LMSI's Quality management program were adhered to throughout the acquisition stage of this project to ensure product quality.