Optech

Sensor Fusion

Optech is the world leader in the development and manufacture of advanced laser-based survey instruments, including industrial lidar, bathymetric lidar, airborne terrestrial lidar, space-based lidar and tripod-mounted lidar systems.

While each specializes in a particular area, sensor fusion — combining lidar data collected by two or more methods - provides information unavailable from any individual system.

The project described here demonstrates how fusing data from complementary lidar sensors can produce a complete, accurate solid model. Data was collected on the city hall grounds of Toronto, Canada using Optech's ILRIS-3D tripod-mounted laser scanner and Optech's Airborne Laser Terrain Mapper (ALTM).

The project consisted of collecting the lidar data, processing the data, aligning the data, fusing the data from each lidar system and, finally, creating the solid model.

Data Collection

The first set of lidar data was collected using an ALTM 2050 mounted in a Piper Navajo aircraft. Data was collected from 850 m AGL, with a point density of 60 cm, to maximize data accuracy and measurement density while still providing economical data collection.

Using Optech's REALM Survey Suite software, range data was seamlessly combined with GPS/inertial data to calculate the position of each measurement in a real-world co-ordinate system (UTM).

Optech's ALTM 2050

The second set of lidar data was collected using ILRIS-3D. The characteristics of the survey site presented a challenge, primarily because of the dense city core and tall buildings surrounding the site, and because construction and security limited access to the site.

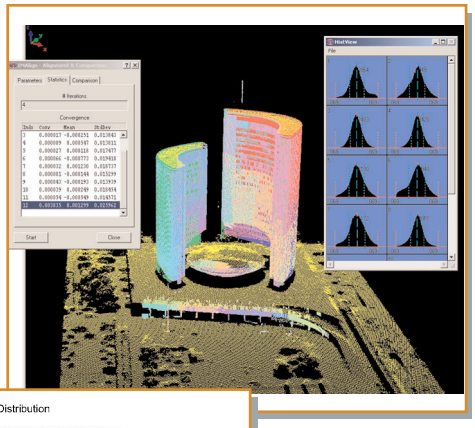
Fortunately, the ILRIS-3D has long ranging capabilities (up to 1,000 m). Where a long, direct line of sight was available, data could be collected at long range. This reduced the number of scans and the processing time.

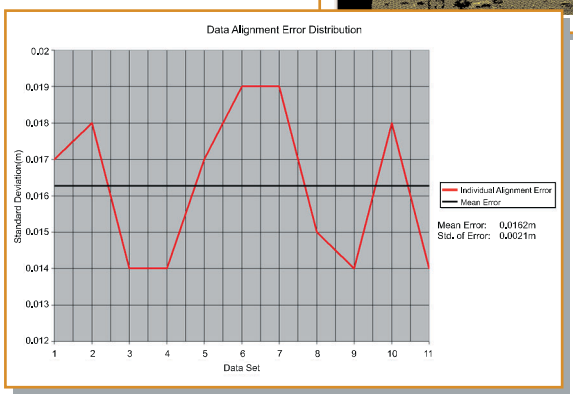
A total of 12 scans were collected over two days, ranging in resolution from 29 mm to 63 mm. The minimum and maximum range of the scans was 74 m and 164 m.

Data Alignment

The alignment of each data set was done with Polyworks™, because it allows multiple scans to be aligned targetlessly.

The average RMS error in the alignment of each scan was 0.015 m. Upon completion, a "global" alignment was executed to distribute the alignment error equally across each cutline.





Above: Alignment statistics for all data collected. Gaussian curves indicate a normal distribution of error.
Left: Magnitude of alignment error for each ILRIS-3D scan.

ILRIS 3D

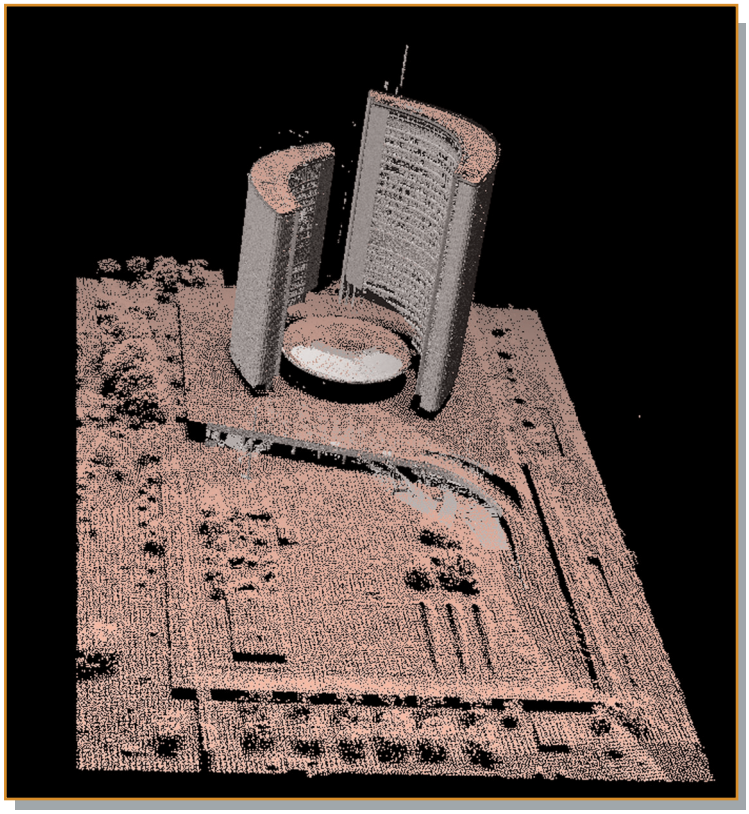
Data Fusion

Two methods were available to fuse the ground and airborne sensor data: georeferencing the ground and airborne data, or aligning both data sets by identifying common points.

For this project the data was fused by using common points to align the data sets.

The major obstacle in fusing the data was identifying enough redundant data to complete the alignment. This was a challenge because airborne data provides information on the top of the structure, while ground data provides data primarily on the sides of the structure. To accommodate this, the corners of roofs were used as common points. Using this method, even with very little redundant data, one can be confident that an accurate common point is selected based on the geometry of the two data sets.

The RMS of the fusion was 17 mm.



Fused sensor data: ILRIS-3D data is grey, ALTM data is pink.

Solid Model

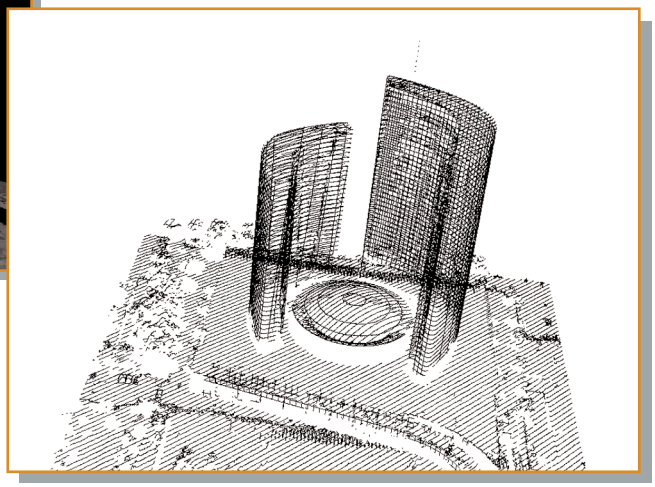
PolyWorks™ was once again used as the modeling software, and the final solid model consisted of 4.3 million triangles, with a resolution of 8 cm and a file size of 125 MB.

Above: final solid model of fused data.
Right: Two-meter cross-sections of the solid model.

Conclusion

While airborne scanners are ideal for broad, large-scale surveys, and tripod-mounted scanners provide high-quality data on a smaller scale, this project demonstrates that data collected from both platforms can be fused in a straightforward, easy manner. Since the product produced by each is very similar, fusion involves little planning and few extra steps.

It is clear that data fusion produces clean, accurate and useful data.



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