Mobile Corridor Mapping

Lynx Application Note: LY-004 Rev A

Figure 1: Lynx Mobile Mapper mounted on survey vehicle.

Challenge: Hurricane Damage Control

In August, 2005, Hurricane Katrina devastated the Gulf Coast of the United States, leaving in its wake an unprecedented loss of life and property damage. Among the critical infrastructure the storm impacted was the levee system that controls the Mississippi River's flow around the city of New Orleans.

After Hurricane Katrina, a surveying firm was asked to see if the existing levee system could be surveyed to within an accuracy standard of 3-5 centimeters (cm). First the client inquired about airborne lidar data—that is, surveying the levees from an aircraft flying overhead using an airborne laser scanner—assuming that this would be the fastest way to gather topographic data.

The firm informed the client of another option, mobile lidar mapping. Like airborne mapping, terrestrial mobile mapping exploits the same technology, lidar (LIght Detection And Ranging). But instead of the lidar equipment being installed in an aircraft, it is mounted on a ground survey vehicle such as a car, van or truck (Figure 1). Assured that terrestrial mobile mapping would be just as accurate and efficient as airborne mapping, the client decided to test this method.

Solution: Test and Control

Optech's Lynx Mobile Mapper was deployed to the New Orleans area to collect spatial data from a 1.3-mile section of levee along the Mississippi River. The Lynx data was referenced to a NGS survey point less than one mile from the project location, and no farther than 2.2 miles from the extents of the project limit.

The survey vehicle drove along the top of the levee while the Lynx sensors scanned the surrounding area. The levee test section was driven twice, once north and once south. When combined with the two Lynx sensors on the Lynx, each pointing a different way, the levee was effectively surveyed 4 times, yielding 4 lidar data strips showing 4 different survey orientations.

The client's concern with achieving the desired accuracy from a comparatively new technology was addressed by comparing Lynx-acquired data with data from the same area gathered by more familiar methods. To do this, the surveyor used survey-grade Trimble GPS equipment to collect a series of ground survey points from a railroad that runs parallel to the levee. This data was regulated to achieve sub-centimeter accuracies and would be used as a control to check the Lynx data. The GPS survey control data was not used to develop a transformation for the Lynx lidar data in order to improve the results. Rather, the client was interested in seeing if the Lynx Mobile Mapper could achieve the required accuracies without improving its data by using the survey control information.

Collection time	1 hour, including setup
Vehicle speed	20-35 mph
Data density	1,000-2,000 points per meter, approx.
Data collection rate	400 kHz (200 kHz x 2 sensors)
Control points	1 NGS point at one end of survey corridor
Corridor length	1.3 miles

Data: Processing and Analysis

The combined solution of the differential kinematic GPS data yielded separation accuracies of less than 1 cm. The IMU data was reviewed and showed that there was almost no drift or degradation recorded by the IMU. The two-GPS antenna configuration, plus the addition of a Distance Measurement Indicator (DMI)—the standard configuration in all Lynx Mobile Mappers—also helped improve the data.

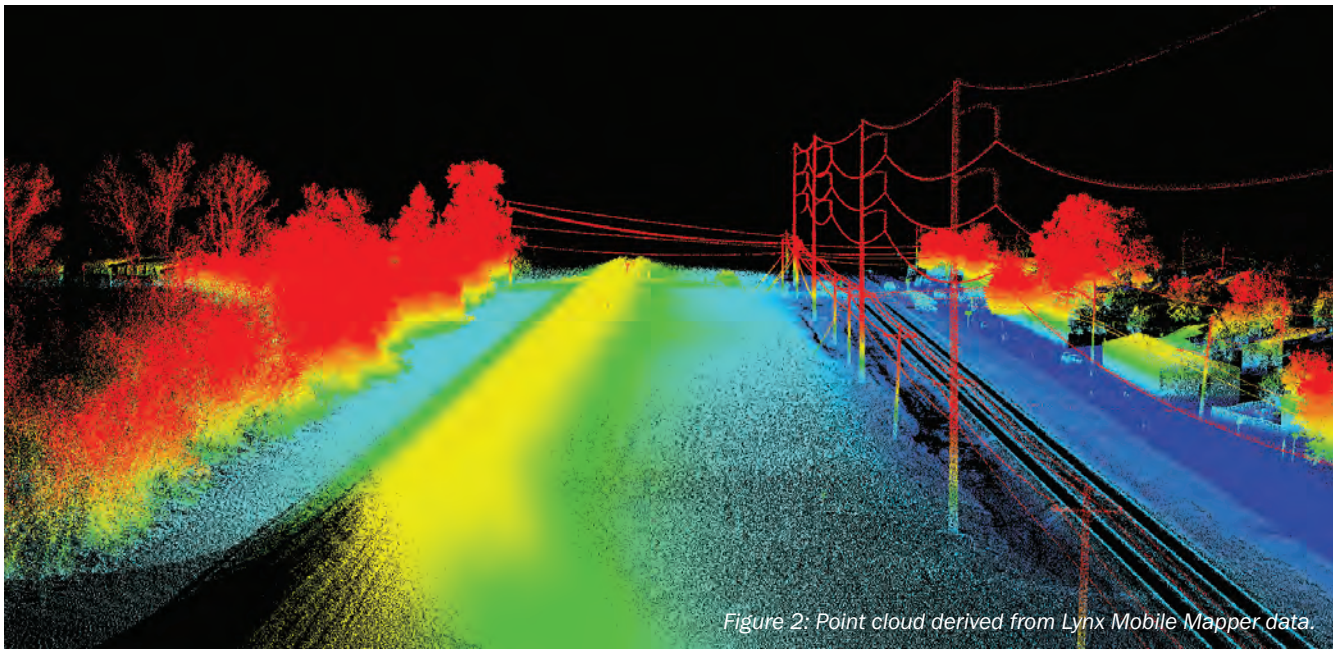

Figure 2: Point cloud derived from Lynx Mobile Mapper data.

Figure 2 shows a point cloud of the levee derived from Lynx Mobile Mapper data and output through QT Modeler visualization software. The visualized data is the product of two scans, one from each sensor and both scanning in the same direction. The density and detail of the point cloud are striking: tree foliage, power lines, railroad tracks and cars parked along the street are all clearly delineated. The accuracy of this visual rendering is particularly impressive, given that objects such as the railroad tracks are 50 m away from the area of interest.

Comparison of difference between scans	
Total samples	3,086
Difference of 0	1,146 (37%)
Difference of 3 cm	170 samples (5%)
Result: 95% of samples within 2 cm of each other	

Future Applications

Lidar technology helps engineers to assess the current state of the levee systems. A number of indicators can be checked, such as subsidence monitoring around flood walls. This monitoring is important to ensure that levee walls and pilings are rooted sufficiently deeply in the subsurface. Engineering-grade surveys that enable detailed measurement of the levees are critical, and the data required to accomplish this is easily obtained by lidar scanning.

Change-detection in the physical levees is another vital application, because analysis can reveal gradual movement that would otherwise go undetected. This proactive measure can detect where failures could occur, and thereby enable problem areas to be shored up. The result not only assists in building stronger flood walls and pilings, but will also save property—and more importantly, lives—if the New Orleans area experiences another hurricane of Katrina's magnitude.

Results: Proven High Accuracy

The Lynx Mobile Mapper performed very well, especially considering the fact that the data was referenced to only one NGS point, and no adjustment or transformation was applied to fit the data within the survey parameters. If the data were transformed to the survey points, it would be reasonable to expect an overall result of less than 1 cm.

Processing time	2 hours
Processed points	50 million points per sensor per lidar strip (approx 100 million points per survey)
Separation accuracies	<1 cm
Accuracy compared to control data	<4 cm without adjustments (RMSE 2.4 cm)
Data set size	50 GB after processing, including raw and processed data

Lynx's demonstrated accuracy—3 cm or better—exceeded the client's requested specification of 3-5 cm. Highly accurate Lynx data sets are higher-resolution and contain less laser shadowing than airborne data. The demonstration proved that Optech's Lynx Mobile Mapper is a safe, efficient and cost-effective survey tool.

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