LYNX MOBILE MAPPER™: THE NEW SURVEY TECHNOLOGY

Federica Zampa  
Sineco SpA  
V. le Isonzo, 14/1, Milan, 20135, Italy  
federica.zampa@sineco.co.it

Dario Conforti  
Optech Incorporated  
300 Interchange Way, Vaughan, Ontario, Canada, L4K 5Z8  
dario@optech.ca

ABSTRACT

The LYNX Mobile Mapper™ is the new lidar solution developed for surveying large areas that are impractical to scan with static lidar sensors but that require an accuracy and resolution that exceed those of airborne technologies. The LYNX Mobile Mapper scans at speeds of up to 100 km/hr, obtaining a system accuracy of better than 5 cm and a resolution of up to 7 mm. Its high-resolution and low-noise data streamlines the delivery of CAD drawings of overpass structures, surface curvature and deformation analysis, safety barrier analysis, and clearance calculations, among others.

This paper presents two applications: the survey of a Greek highway (Korinthos – Tripoli, March 2008) and, for historical preservation, the survey of several major roads in Milan's city center. The paper traces the entire survey workflow, from the project planning in the office through the actual field survey to the final data processing with commercial software.

The paper analyzes the advantages and disadvantages of this lidar technology in different environments, its accuracy and data quality, safety and field work, office post-processing workflows, and the generation of final products and related issues, as well as a comparison against the same surveys done by a static laser scanner.

INTRODUCTION

In 2006 Sineco S.p.A., an Italian engineering firm of the ASTM Group, decided to enter the mobile mapping market and began a collaboration with Optech Incorporated, the Canadian manufacturer of advanced laser-based imaging systems, to develop a new mobile mapping system. The first prototype, delivered at the beginning of 2007, was based on a platform combining two ILRIS-3D static laser scanners (scanning horizontal and vertical) and a position and orientation system (Applanix POS LV 420), which consisted of an inertial measurement unit (IMU), two dual-frequency GPS receivers and a distance measurement indicator. This was the proof-of-concept that paved the way for the development of the new LYNX Mobile Mapper™, a fully integrated system with 360° laser sensors that surveys large areas from a mobile platform at very high speeds (up to 100 km/hour), obtaining a 360° high-resolution (up to 1 cm) point cloud.

This paper presents the surveys of two different subjects: a highway in Greece and a city centre in England, providing an accurate description of how mobile mapping technology can work in these environments.

The first survey was carried out in March 2008 on the highway connecting Korinthos to Athens in Greece. The survey area consisted of a 60-km stretch of highway (a total of 120 km for both carriageways) with the vehicle moving at a speed of 60 km/hr. The main goal was to survey both carriageways, then reconstruct an accurate 3D model of them.

The second example presents the results of a survey carried out in January 2008 in England, of an urban area in Leicester city center. In this case the final aim of the work was the accurate 3D modeling and reconstruction of an urban area.
THE TECHNOLOGY

Mobile lidar systems are generally designed for collecting engineering/survey grade lidar data over large areas that are impractical to survey with static lidar sensors yet require an accuracy and resolution that exceed airborne technologies. With system accuracy better than 5 cm, a measurement rate of 100,000 points per second per sensor, a 360° field-of-view and a resolution of up to 1 cm, the Lynx Mobile Mapper has a feature set that allows for the generation of high resolution data at high vehicle speeds.

The Sineco system uses a platform rigidly mounted on top of a vehicle (Figure 1). The platform hosts two oriented lidar sensors as well as the IMU and GPS antennae. A rigid design for the entire mounting structure ensures that alignment and accuracy between the sensors and the navigational equipment is maintained.

![Van with all the system components.](image)

Figure 1. Van with all the system components.

The dual-sensor configuration scans the entire survey area and minimizes the shadowing caused by objects along the roadside while optimizing the field-of-view to full coverage.
The navigation solution is a critical component for any mobile system. In this case the Applanix POS/LV 420 was used to correct the orientation and position of the two lidar sensors generating a complete geo-referenced point cloud automatically. In brief, the position and orientation solution (POS) makes use of an IMU and GPS. The IMU contains three accelerometers and three gyroscopes which measure the acceleration and angular velocity necessary for computing all aspects of the vehicle motion: position, speed, acceleration, orientation and rotation. Two dual-frequency (L1/L2) GPS receivers track and record the vehicle path. Differential GPS processing is used to correct and refine the geo-referenced data.

SYSTEM INTEGRATION

The connectivity between the lidar sensors and POS is limited to synchronizing the clocks between the instruments. This operation is executed by setting up a GPS PPS connection that lets the laser timestamp events with its local clock. At the same time a GPS NMEA string is required to indicate the precise GPS time of the previous PPS event. The lidar sensors then use this time to establish the offset between their local clocks and GPS time.

POS has its own orientation and position above the platform and it is important to know the exact orientation and location of both lidar sensors with regard to the POS. For this reason mobile lidar sensors must be calibration after they are mounted to the vehicle.

SURVEY AREA 1: HIGHWAY, KORINTHOS – ATHENS

This work was carried out in March 2008 and surveyed a total 120 km of highway between Korinthos and Athens in Greece, consisting of three lanes plus the shoulder.
The aim of the project was to obtain a CAD reconstruction of the existing main features—pavement, structures, slopes, road signs, poles, etc.—as new work was planned on this highway, including the construction of a new link-up motorway and the preservation of existing parts.

The resulting point cloud was an efficient archiving of the “as built” structures for future reference.

The highway was surveyed in only three hours at an average speed of 50 km/hr and acquired 980 million points. The point cloud was generated in WGS84/UTM34 and later converted in the Greek reference system, CGR87, with a final average spot spacing of 11 cm. In order to increase the final point cloud accuracy, six base stations and some ground control points (every 50-80 meters) were located along the entire survey area. The final point cloud accuracy was within 1-2 cm.

In order to get all the results needed, different software (PolyWorks and Pointools) was used for data processing.

Figure 3. CAD drawing and Mesh.

Figure 4. Lynx point cloud.
SURVEY AREA 2: CITY MODELING

This survey was carried out in January 2008 in Leicester, England. The aim of the project was to obtain a faithful model reconstruction of some of the main buildings in the historical area for a complete digital archive. Due to the narrow streets and tall buildings, the GPS signal was occasionally interrupted (GPS outage); fortunately, the POS can correct the location by using the DMI (Distance Measurement Indicator): The DMI is a wheel-mounted rotary shaft encoder that measures the precise linear distance traveled. These measurements give the POS LV a very accurate velocity measurement that helps constrain drift errors during GPS outages.

Due to traffic congestion the entire area had to be scanned at an average speed of 30 km/h, while collecting data with spot spacing of about 4 cm. In 20 minutes the LYNX Mobile Mapper scanned five blocks for a total of 144 million points. All the pre-processing was carried out using a single GPS base station placed around the area. The processing was done with Pointools software.
CONCLUSION

The two field tests demonstrate how mobile lidar technology can be used to conduct corridor surveys at an impressive speed, without disrupting traffic and—in importantly—in a safe fashion.

One dramatic comparison puts it in perspective: In 2007, scanning 80 km of highway using a traditional ground-based laser scanner and a Total Station required 120 working days to complete the field survey. In the demonstration
conducted in Greece in 2008, the LYNX Mobile Mapper scanned 120 kilometers of highway in three hours. The results speak for themselves.

The geo-referenced point clouds obtained have a very high-resolution and provide a complete database of information that anyone can examine anytime. The high-density point cloud allows for easy identification of objects such as structures, slopes, road signs, poles, buildings features, etc. Sineco is now developing some automatic routines for feature extraction and collection, automatic cross-section creation and data segmentation.

CREDITS

The authors thank Michael Xinogalos for all the hard work performed over the last two years as well as the entire Astrolabe Engineering firm (www.astrolabe.gr). A special thanks also goes to Faraz Ravi of Pointools LTD for helping us during the data processing and modeling stages (www.pointools.com).

FURTHER READING

Sineco: http://sinecolaser.com

ABOUT THE AUTHORS

Federica Zampa graduated with high marks in Environmental Engineering. She worked as a GIS and IT Specialist in two high-profile Research Centers: ITC – Irs Centre for Scientific and Technologic Research and CEH Edinburgh. In early 2006 she joined Sineco S.p.A. and works as a Project Manager in the Research and New Technologies Development area, paying special attention to new laser mobile system development.

Dario Conforti has a degree in Urban Architecture from the Polytechnic University of Milan. His studies included both cartography and photogrammetry. With seven years experience in laser scanner technology, he joined Optech Incorporated in early 2006 as a worldwide Technical Support Specialist. He also has extensive experience in GPS, bathymetry and airborne photogrammetry.