



MOBILE LASER SCANNING ON THE ROAD!

A FULLY INTEGRATED RIEGL MOBILE LASER SCANNING SYSTEM IS TESTED IN THE AUSTRALIAN FIELD

Mobile laser scanning (MLS) is an emerging technology, with rapidly growing importance for the surveying community. High-speed data acquisition from moving platforms has compelling advantages compared to conventional terrestrial laser scanning for several traditional and novel fields of application.

RIEGL, leading manufacturer of laser scanners for terrestrial, mobile, airborne and industrial applications, has taken this challenge by developing and presenting the VMX-250, a unique mobile laser scanning solution. The fully integrated system comprises two calibrated laser scanners, a high-grade inertial and satellite navigation system (INS-GNSS), and the corresponding software, reducing the complexity of integration, installation, and post processing to a minimum. The system can easily be mounted on the roof-rack of a vehicle by means of a genuine mounting mechanism. Self-contained calibration of the individual subsystems, with respect to each other, is maintained even if the system is removed, e.g. during transport.

After the official launch of the new system, expectancy was enormous. Initial reference projects around the world had to prove the VMX 250 performance - and it fully met the anticipation by fast data acquisition, excellent data quality and user friendliness.

The System

The VMX-250 System consists of two RIEGL VQ-250 "Full Circle" Laser Scanners, which are very high-speed, non-contact profile measuring



RIEGL VMX-250 Mobile Laser Scanning System: Easily mountable on the roof rack of a car

instruments, with a laser pulse repetition rate (PRR) up to 300 kHz, using a narrow infrared laser beam and a fast line scanning mechanism. Acquisition of 360 degrees and ranges up to 500 meters characterize the scanners which show a precision of 5 mm and excellent multiple target echo discrimination, even under adverse atmospheric conditions. Both laser scanners are operated synchronously during a survey, gathering three-dimensional (3D) data at twice the measurement rate of a single scanner, providing 600,000 measurements per second in total. That way, the system is enabling an extremely fast, efficient and highly accurate 3D mapping of highways, streets, railroads, and the like.

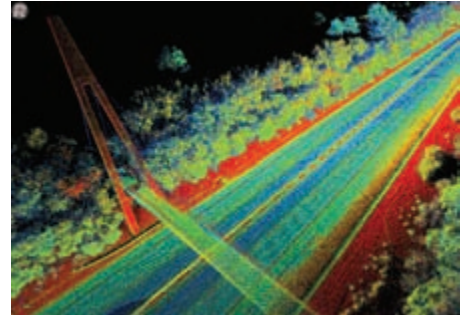
The unique RIEGL technologies, "Echo Signal Digitization" and "Online Waveform Analysis", result in excellent multi-target detection, even of 3D data of objects, which are obscured by physical entities in the foreground, like fences or vegetation. This opens new capabilities for the processing and transformation of measured data into a 3D computer model.

The system configuration further comprises the latest modular sub-systems based on inertial and global navigation satellite systems (GNSS), offering hardware for real-time kinematic (RTK) data processing and integrating three sensors: an inertial measuring unit (IMU), a global GNSS receiver, including an antenna, and a distance measuring indicator (DMI). The scanners and the INS-GNSS unit are mounted tightly-coupled on and within a rigid sub-mount, intended to be carried by a vehicle, for instance on the roof rack of a car. A single cable connects the acquisition platform and the control unit placed inside the car, which contains the power supply, an embedded computer running RIEGL's acquisition software RiACQUIRE, removable storage disks, and a

handy touch screen, providing a comfortable control interface for the operator.

In April this year, a VMX-250 demo unit was sent to RIEGL's Australian distributor CR Kennedy Pty Ltd, to be presented at the FIG 2010 in Sydney, and to execute reference projects by surveying a highway section in the close vicinity of Sydney.

"Efforts for installing and starting up the VMX-250 are limited to a minimum. For the Australian mission the system was sent to Sydney by air freight. It took less than two hours to get the whole system mounted on a Land Rover, and to start calibrations and test drives," reported Nikolaus Studnicka, Manager International Sales at RIEGL, excited about the VMX-250's user friendliness. "It was our goal to present a combined data set of several famous sights acquired by car and boat. So after the first day of scanning the Sydney Opera House, Harbour Bridge and Downtown Sydney by car, we rented a boat for repeating acquisition from the seaside. As often in spontaneous circumstances, some improvisational skills were necessary – yet, the



Surveying data of the highway acquired with the RIEGL VMX-250: Color-coded point cloud based on the reflectance of the target

whole installation on the rented diving boat was done in little more than an hour."

Test Track HIGHWAY

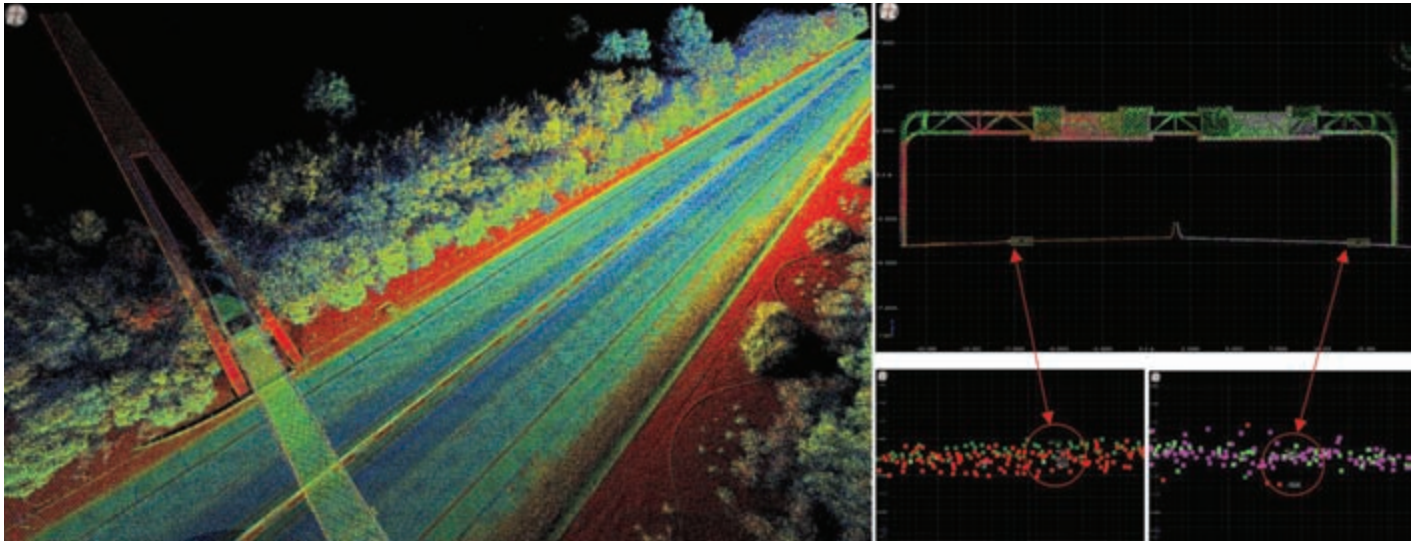
"We were really impressed. The Sydney data acquired by car and boat for the combined data set fit perfectly. It needed just one day to analyze and process the loads of data, to prepare sample data and to cut a little demo movie", commented John Reddington, National Laser Scanning Manager at CR Kennedy, "But we wanted to see more: We had arranged demonstrations with potential customers, who wanted to see the system managing the tasks of their special applications." Surveying a highway section, as a reference project, should show if the system would be able to meet the expectations.

"The day of data acquisition, the GNSS conditions, that are visibility of a sufficient number of navigation satellites above the horizon, proved rather good. We took the testing route during normal traffic at a speed of about 65, 70 km/h. So preconditions were ok. Yet, there was one important challenge: Would we be able to attain a vertical precision of 15mm, as asked for?" reported Studnicka.

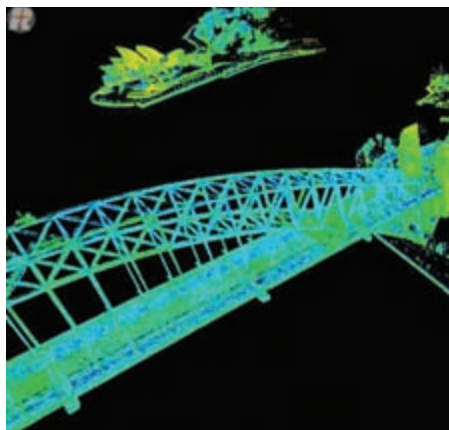
Data acquisition was realized while driving on the highway in both directions, with both laser scanners operating. The INS-GNSS unit provided the route, the so-called 'trajectory'. Additionally, a similar method, as used in airborne scanning - known as "Scan Data



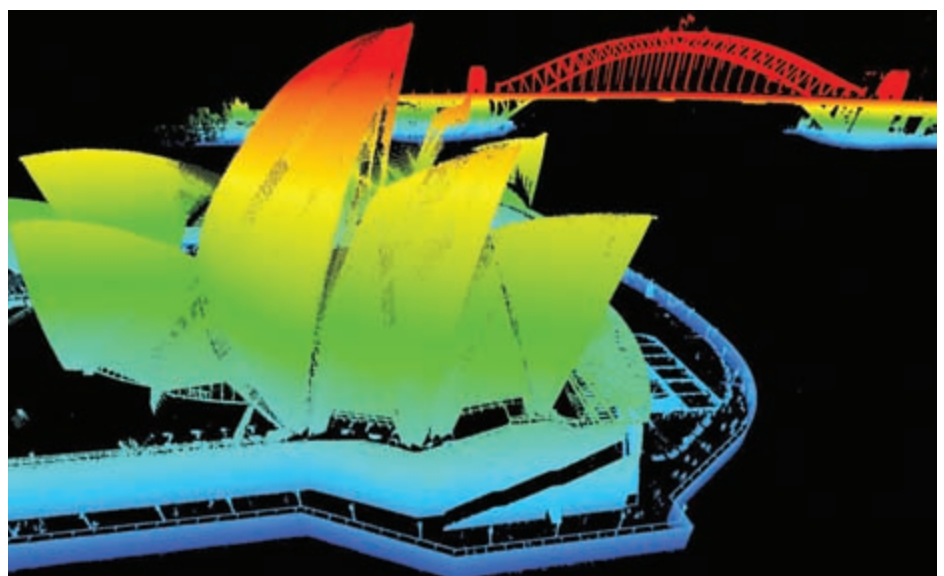
The RIEGL VMX-250 in Australia



Cross-section of the scanned highway data: profile of the road across all lanes, with magnification of the point cloud in the close vicinity of the control points



Impressions of Sydney: The Harbor Bridge and the famous Opera House, scanned by the RIEGL VMX-250 mounted on a boat.



Adjustment" - was applied, in order to refine the adjustment of both separate scan drives in opposite directions.

To evaluate the quality of the geo-referenced data set, prepared by means of RIEGL's processing software RiPROCESS, previously measured terrestrial control points were used. A comparison, taking into account the point clouds of all four superposed scans (scanner 1 and scanner 2 in both drive directions, each), finally showed an astonishing precision of 8 mm. The final point cloud of the 2 km highway section covers approximately 140 million geo-referenced points, with an average point density of around 2,000 points/m² on the road surface, which allows a detailed inspection of road conditions (detection of cracks and trenches, monitoring of repair work, and the like).

Thus, the system proved its performance in the field. Leigh Finlay, Practice Leader at Sinclair Knight Merz, one of Australia's largest Engineering and Surveying consultants stated, *"In the past, the survey of a particular piece of road or rail line took a great deal of time and involved significant safety risks. This mobile laser scanning system enables our teams to travel a route in few minutes, gather data and safely return to our offices to convert the point cloud*

data into a form that can be used by our engineers for our clients." Shortly after the RIEGL demonstration, SKM decided to order the new system.

Conclusion

The VMX-250 is a compact, flexible, high performance Mobile Laser Scanning System providing state-of-the-art laser scanning technology and data processing. Smooth interaction of hardware and software allows on-line monitoring of system parameters and reduces the need for time-consuming post-processing to a minimum. The digital interfaces of the system are prepared for the integration of user-specific camera equipment. A flexible and modular camera system for the VMX-250 recently was introduced at this year's Intergeo.

Further projects, like scanning a pipe bridge, and an open pit mining area in Germany; as well as scanning a test track of the university in downtown Helsinki, also proved the accuracy and the versatility of the system.

As the system is equipped with a type of IMU sensor, with minimum export restrictions,

it can be shipped to and legally operated in virtually every country in the world.

The superior performance of state-of-the-art, fully digitizing online waveform processing laser scanners, is optimally exploited when used in a mobile laser scanning context. At 600,000 time-of-flight range measurements per second, the RIEGL VMX-250 mobile laser scanning system allows surveyors to capture highly accurate and high-resolution dynamic 3-dimensional spatial data at normal traffic speeds. The cutting edge multi-target capability enables penetration of foliage, fences, and other obstacles. The calibrated relative reflectance reading(s) allows for range-independent grey-coded texturing of, e.g., facades and the automatic, range-independent identification of traffic signs. Employing accurately calibrated digital cameras enables the combination of photogrammetry and laser scanning. Field data is presented demonstrating the accuracy of the calibration and the high quality of the geo-referenced colored point cloud.

Article by RIEGL
www.riegl.com