Mountain Surveying Made Easy with Galaxy's SwathTRAK™ Technology

Between the City of Portland and the Pacific Ocean in northwest Oregon, lies a heavily forested mountainous area managed by the Oregon Department of Forestry (ODF). Within this region (latitude approximately 45° 44', longitude -123° 32') lies the Salmonberry block, a 70 mi² tract with elevations ranging from 300' to 3000' AMSL.

Historically, obtaining accurate surveys of such inaccessible land was exceedingly difficult, if not impossible. As technology progressed, airborne lidar mapping became the fastest, most accurate method for surveying such areas. Yet even some of the most advanced lidars have been challenged when deployed over highly variable terrain. Due to the constant and drastic elevation changes characteristic of such terrain, data quality has often been compromised.

Aerial oblique view of the Salmonberry block, northwest Oregon.

THE CHALLENGE OF HIGHLY VARIED TERRAIN

It is more challenging to obtain high-density, high-accuracy, georeferenced point data from extremely mountainous terrain than from relatively flat open terrain. One reason for this is that the laser's swath width varies markedly between narrow mountain peaks and broad slopes in adjacent valleys.

Across a comparatively narrow mountain peak the sensor collects a very dense concentration of points (oversample). Scanning an adjacent valley, however, the sensor "sweeps" a wider swath than on the narrow peak. As laser pulse repetition frequency (the number of pulses emitted per second) is typically the same for both peaks and valleys, the swath, spread over the wider valley, ends up with a lower concentration of points (undersample). Consequently, in highly varied terrain where topography changes quickly and constantly, it is very difficult to acquire data

Corporate Profile

Teledyne Optech is the world leader in high-accuracy 3D lidar survey systems, integrated cameras, and productivity-enhancing workflows. With operations worldwide, Teledyne Optech offers standalone and fully integrated lidar and camera solutions for airborne mapping, airborne lidar bathymetry, mobile mapping, and static laser scanning.

Teledyne Optech's high-performance airborne lidars deliver industry-leading precision without sacrificing productivity: The ultra-compact Galaxy delivers consistent data even in mountainous terrain while the award-winning multispectral Titan handles topo/bathy and terrain classification. Both Titan and Galaxy integrate seamlessly with our airborne cameras to fit application requirements, and combine planning, operation and real-time data visualization with the Optech Flight Management Suite (FMS). All of our airborne systems use the Optech Lidar Mapping Suite (LMS) for automatic rectification of both lidar and camera data.

Already in use with several government agencies, the Optech CZMIL Nova airborne bathymetric mapping system outperforms comparable systems in turbid-water penetration and is available for rental for short- or medium-term projects. Its HydroFusion workflow automatically fuses lidar, RGB and hyperspectral data to generate seamless topo/bathy 3D maps, benthic classification, object detection and more.

The Optech Lynx MG, SG, and SG-S mobile lidar systems efficiently collect highly accurate and dense data at highway speeds, leveraging the same LMS workflow as the airborne sensors. The Optech ILRIS terrestrial laser scanner is a complete, portable solution for commercial engineering and mining surveys, with several application-specific peripherals.

with consistent point distribution without essentially over-collecting the area.

Furthermore, to avoid data gaps between flight lines, the lidar operator must plan a minimum flight line sidelap. To accommodate narrow swaths over mountain peaks, spacing between flight lines is decreased. Surveys over highly varied terrain therefore require more flight lines than flat terrain surveys. The math is straightforward: More flight lines leads to longer acquisition times, resulting in higher costs.

The latest generation of lidar sensor from Teledyne Optech, the Galaxy, was designed to overcome the challenges of mountain surveying, including pulse-in-air (PIA) "blind zones" and inconsistent point distribution and point density. So-called blind zones occur when the laser emits pulses at very high frequency while the aircraft flies at high altitude. Under these conditions a return pulse, i.e., a pulse reflected from a prior emission, can "collide" with an outgoing pulse, thereby canceling each other out. This collision zone is often referred to as a "blind zone."

Lidar manufacturers use different methods to avoid blind zones, but the related problem of uneven point distribution due to continuous elevation changes in highly varied terrain seemed unsolvable until the Galaxy offered a unique, patent-pending technology solution called SwathTRAK™.

SwathTRAK addresses the challenge of continuously changing swath widths (narrow peaks vs. broad valleys). As the aircraft flies over high-elevation mountain peaks and low-elevation valleys, SwathTRAK uses the sensor's real-time surface monitoring capability to dynamically adjust the scanner's field of view (FOV). On-the-fly adjustments enable the scanner to adapt to the ever-changing terrain below. From peak to valley, point distribution is significantly more uniform when using SwathTRAK.

How much more uniform? GeoTerra, an aerial mapping services provider, flew large tracts of highly varied terrain in northwest Oregon using two different lidar systems: Teledyne Optech's Orion H300 and its newer Galaxy with SwathTRAK.

The ODF needed accurate, up-to-date 3D spatial data for purposes of natural resource management, transportation applications, strategic planning and recreation site management. GeoTerra carried out surveys to deliver a number of data sets needed in various formats, including: All Return Point Clouds (LAS), Highest-hit DEM (Esri), Bare-earth Surface Model (Esri), Intensity imagery (TIFF) and Metadata along with a full survey report.

In the Salmonberry block of the ODF project, the older Orion sensor was used, while additional areas were flown with the new Galaxy sensor over similar terrain. A performance comparison between the two systems was easily made by comparing acquisition times broken down on a per square mile basis. In addition, final flight plans were created for both sensor systems on all areas, providing a second method of comparison based upon the acquisition plan or model.

The improvements in efficiency shown in Table 1 are clear. In particular, the total time saved by taking advantage of Galaxy's SwathTRAK technology resulted in a more cost-effective survey.

	Orion	Galaxy
Survey Parameters		
Project Area	70 sq mi	70 sq mi
Point density	> 8 ppm	> 8 ppm
Aircraft speed	85 knots	140 knots*
Altitude	1525 m AGL	1650 m AGL*
Sensor Parameters		
PulseTRAK™	N/A	ON
SwathTRAK™	N/A	ON
Laser PRF	150 kHz	400 kHz*
FOV	26-	32- *
Sidelap	50.00%	> 50.00%*
Swath width	704 m flat ground	946 m flat ground*
No. of flightlines	61	33*
Time on line	5.25 hrs	2.5 hrs*
Total time	8.5-9 hrs	4 hrs*

*Galaxy's ability to operate at higher altitudes, increased PRF, wider FOV and faster speeds allowed GeoTerra to cover more area at a faster rate, resulting in greater efficiencies and reduced costs.

Bret Hazell, President of GeoTerra noted, "Some of the efficiencies that Optech predicted didn't anticipate efficiencies gained in the severe mountainous and forested terrain we deal with. Optech estimated maybe 40%, but after comparing areas, collection plans, and actual acquisition using both the Orion and the Galaxy, we found that lidar data collection efficiency improved by just over 50% in reduced acquisition times."

Given the timing of the ODF project, the similar terrain within subareas, and GeoTerra's acquisition of a new Galaxy sensor in the interim, the opportunity arose to perform a series of surveys with the same parameters, area coverage, point density and deliverables, textbook cases for comparison. The results are good news, both for lidar service providers and their clients. What has long been a challenge — getting consistent high-quality lidar data from highly varied terrain — just got a lot easier by using the Galaxy's SwathTRAK technology. ■

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GALAXY™

Galaxy with SwathTRAK™ technology

Save **Time & Money!**

Teledyne Optech's new Galaxy airborne lidar sensor with SwathTRAK™ technology achieves tremendous density performance and up to a ***40% increase*** in collection efficiency over traditional fixed-FOV sensors. By automatically adjusting the sensor's scan FOV in response to changes in terrain elevation, the Galaxy delivers superior data consistency with uniform swath widths.

- Maintain a constant swath width on the ground, even in complex terrain
- Achieve consistent point density on mountain peaks and valleys within a single swath
- Automatically maintain planned point density despite changes in flight altitude
- Save up to 40% on collection costs, compared to traditional fixed-FOV sensors

Contact Teledyne Optech today to learn how the Galaxy with SwathTRAK™ can save you time and money.

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