ALTM Orion: Performance Possibilities of an Ultra-Compact Topographic Mapping System

By Michael R. Sitar, Product Manager (Airborne), Optech Incorporated, Canada

Observing, understanding and anticipating changes in the airborne mapping industry is critical to being able to provide sensor solutions and capabilities that are both competitive and appropriate to end-users. Optech Incorporated's efforts in this regard are apparent in the simple fact that many of today's lidar sensor configurations and their inherent features—irrespective of manufacturer—can be traced directly to Optech innovations. These include scanner roll compensation for data swath centering immediately below the sensor platform, waveform cross-section measures (commonly referred to as "intensity"), real-time lidar swath coverage display for in-air collection confidence, and Continuous Multi-Pulse technology (CMP) for doubling collection altitude for a given laser sampling rate without the need to plan around sensor range gates.

The recent launch of the ALTM Orion represents a radical departure from the traditional sensor configurations typically associated with large scale mapping capabilities. Demands for smaller airborne platforms with decreased operating costs, and an unprecedented interest in unmanned topographic mapping has driven the development of the ALTM Orion. Now the Orion fulfills a niche market where no commercial-off-the-shelf (COTS) total solution previously existed. Perhaps best of all, the ALTM Orion achieved this without sacrificing the increased performance expectations of the commercial mapping industry.

With a modular construction approach to simplify field-serviceability, and a wide environmental operating envelope, the ALTM Orion was designed for users in survey scenarios where downtime is not an option. Based on Optech's new iFLeX™ technology platform, the ALTM Orion provides a ground-up design approach that incorporates the very latest in technology trends—from micro POS (Position and Orientation System) board sets with fully integrated real-time differential GPS correction capability, to ultra-fast data transfer protocols, to the latest in discrete timing electronics design.

While system reliability and continuing competitive capability is always of key interest, so is overall system precision and accuracy, most notably in the vertical height (Z) component. Optech's commitment to providing its clients with the highest quality raw data possible in a discrete return system is reflected in the ongoing research and development efforts in timing electronics, laser development, and software design. Similarly, critical evaluation and integration of sensor core components creates the difference between merely acceptable data and truly exceptional raw data. The practical difference this makes for the surveyor is that far less effort is required to refine the data iteratively in the post-processing stage.

The initiative behind the ALTM Orion's development also adds value to real-time position data acquisition where XYZI data delivered on-site immediately following collection is becoming possible. This capability is invaluable during episodic climatic events, or in areas susceptible to geomorphic hazards, and for missions requiring rapid-reconnaissance capability. As this expectation steadily gains commercial interest, particularly for improved estimates of data coverage and in-air data quality evaluation, there is a requirement to propel sensor design to new levels of precision and accuracy.

An important component to this process is the critical selection and development of capable laser systems. Extremely narrow and constant pulse-width lasers with high peak power capability and a near-uniform Gaussian distribution are optimal, wherein accuracy is limited only by platform altitude. Coupled with state-of-the-art timing electronics that continuously determine accurate range measures, the laser sub-system represents the heart of a lidar mapping sensor's true capability.

In an effort to characterize and field-qualify the ALTM Orion's new design improvements and laser sub-system performance, multiple flights over several days were performed over a flat airport runway with previously determined Ground Control Points (GCP) along the complete length and width of the paved surface at 5 m intervals. Laser pulse repetition frequencies (PRF) were varied as a function of single-pulse limits, and maximum altitudes adjusted accordingly. The maximum laser PRF available at the time of testing was 100 kHz (higher PRF have since been similarly qualified). Results were also collected over a forested area in an effort to determine the minimum range separation between successive returns from the same outgoing laser pulse. This is a measure of the ability of the receiver and timing electronics to identify discrete objects.

Table 1 identifies the basic system configuration and performance parameters. While a conservative minimum accuracy specification has been determined, the following table provides a glimpse into the precision and accuracy potential of the new ALTM Orion sensor.

Basic System Specifications	
Operational envelope	~200 – 2500m AGL, nominal
Z accuracy	< 5-20 cm; decreasing with maximum AGL
Effective laser repetition rate	Programmable, 50-150 kHz
Scan width (FOV)	50° ; plus 10° roll compensation
Cross-section capture (intensity)	12-bit dynamic range, 4 returns
Laser classification	Class IV (US FDA 21 CFR), 1064 nm
System dimensions / weight	< 0.030 m³ (1.0 cu ft); 27 kg

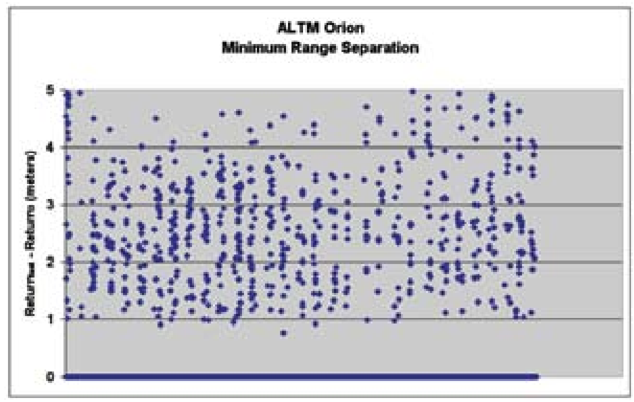
Table 1: ALTM Orion, basic system specifications

Table 2 provides a brief statistical summary of one ALTM Orion's precision capability by analyzing the shot-to-shot elevation differences between successive points on a smooth surface, given a 40 degree FOV. Similarly, general system accuracy capability was determined via the residuals associated with lidar XYZ data and the ground control surface. Reported RMS values include GPS biases normally removed during data post-processing (note: no realtime differential GPS correction was applied).

In summary, this particular ALTM Orion sensor demonstrated a strong potential to significantly surpass the advertised Z-accuracy specification. Additionally, it was observed that discrete objects with < 1.0 m in vertical separation can be identified. While inherent precision and accuracy can and will, vary from system to system, it is clear that this highly innovative topographic mapping solution demonstrates a new level of accuracy capability. Appropriate sensor selection can therefore go a long way to generating maximum up front results in anticipation of industry trends toward accurate realtime data display and output.

Laser PRF (kHz)	Flying Height (m AGL)	Shot to Shot Precision Std 1 (m)	Position Accuracy Std 1 (m)	Position Accuracy RMS (m)
100	1100	0.011	0.023	0.023
100	1100	0.012	0.024	0.027
70	1400	0.026	0.031	0.106
70	1600	0.022	0.031	0.048
50	2400	0.022	0.031	0.032
50	2100	0.018	0.032	0.099

Table 2: ALTM Orion statistical example of individual flight line precision and accuracy capabilities.



▲ *Graphical estimation of the minimum return separation possible with the ALTM Orion.*

CORPORATE PROFILE

Optech Incorporated

300 Interchange Way
Vaughan, Ontario, Canada L4K 5Z8
905-660-0808 • Fax: 905-660-0829 • www.optech.ca

Many Products - One Family

Optech has been in the lidar business for 33 years, helping our customers survey the world. During this time we've created a family of advanced laser-based instruments that fit every survey need on Earth, and beyond. We offer lidar solutions in airborne terrestrial mapping, airborne laser bathymetry, high speed mobile mapping, laser imaging, mine cavity monitoring, industrial process control as well as space-qualified sensors for orbital operations and planetary exploration.

Airborne Survey

Optech's Airborne Survey products excel in the efficient acquisition of high-accuracy spatial data over land and water. With application-specific designs to fit your business focus, Optech's ALTM and SHOALS systems provide the competitive advantage that clients demand.

The new ALTM Orion is the world's smallest airborne lidar mapping solution. With all the performance and features you have come to expect from much larger systems, Orion offers flexibility in installation and application not offered anywhere else.

Mobile Survey

Optech's LYNX Mobile Mapper™ represents the next generation in the rapid collection of survey grade 3D data. This revolutionary mobile mapping system integrates the newest innovation in lidar sensors with the best-of-class imaging, navigation and product warranty and support.

Terrestrial Survey

Optech's ILRIS-3D Intelligent Laser Ranging and Imaging System is a complete, fully portable, laser-based imaging and digitizing system for the commercial survey, engineering, mining and industrial markets.