SINGLE PHOTON LIDAR - IS IT THE BEST SENSOR FOR EVERY JOB?

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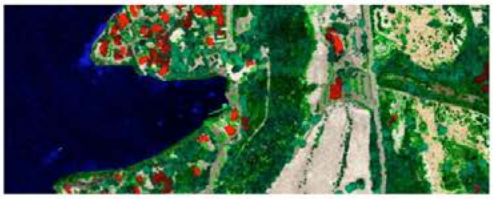
As lidar choices expand, knowing the right tool for the job is key. Single Photon Lidar – SPL offers many benefits over traditional linear mode lidar, but it is not a panacea.

Over the last 25 years, the introduction and evolution of lidar to the geospatial mapping community has revolutionized the digital terrain modeling process. Lidar acquisitions, which literally map at the speed of light, allow for a quick, efficient and highly accurate collection of detailed terrain modeling for an increasing breadth of applications.



The nadir view of the single photon lidar point cloud was collected above Keauhou Bay on the Big Island of Hawaii.

In the last few years, new lidar technologies have entered the market and offered alternatives to traditional linear mode lidar. Each of these has strengths and weaknesses, and each is best suited to different lidar project environments. The key to getting the most impactful and efficient collection is knowing which mode to use for which project.

Big Island of Hawaii Collection Challenges

One example of applying the appropriate lidar tool to the benefit of a specific project was found in a collection conducted in early 2018 on the Big Island of Hawaii. Woolpert worked under a contract through the National Oceanic and Atmospheric Administration (NOAA) and the U.S. Geological Survey (USGS) to provide the technical expertise, services and equipment for the procurement of high-resolution, Quality Level 1 (QL1) lidar data across more than 4,000 square miles of the Aloha State. The project was made possible by the NOAA Office for Coastal Management and its partnership with the USGS and multiple agencies, including the County of Hawaii.

Woolpert has performed several lidar collections for the 3D Elevation Program (3DEP) and others using a variety of lidar sensors over multiple years. The newer single photon lidar (SPL) technology is best known for its ability to collect a point density of around 30 points per square meter from high altitudes, making it a viable option for wide-area, dense lidar survey.

This single photon lidar point cloud image is overlooking Keauhou Bay on the Big Island of Hawaii.

Woolpert first evaluated the single photon lidar technology in 2014 for the USGS by collecting data over 500 square miles of forest and urban terrain in Connecticut. The acquired lidar data was used to deliver QL2 data and to produce digital elevation models (DEMs) during a period when trees were in full leaf and the mixed-use area being mapped was covered with dense vegetation. Such project conditions, i.e. dense vegetation, challenge any lidar system, as it is most common to deploy during leaf-off conditions.

The Hawaii project presented the challenge of collecting data over dense vegetation and had weather patterns that complicated collection opportunities. To address these issues, Woolpert elected to use SPL for the project and selected Leica-Hexagon's SPL100 sensor mounted on a Twin Commander turboprop aircraft.

"The frequent cloud cover in Hawaii creates a narrower window within which to collect data," said John Gerhard, Woolpert vice president and program manager. "Single photon lidar allows us to fly higher and capture a wider swath of ground in less time, while achieving the desired QL1 data at eight points per square meter. This created a greater acquisition efficiency."

The Big Island is predominantly comprised of one large volcano, which has prevailing winds and rain that roll up on one side and create a rain shadow that covers the opposite side. The dry side of the island is more barren, while the side with more precipitation is covered in a dense jungle canopy that is difficult for lidar to penetrate. SPL was chosen due to its ability to collect 6 million points per second using 100 output laser beams.

Strengths and Weaknesses of SPL

"None of the lidar sensors can penetrate the leaves, but the more laser shots you fire down, the more opportunities you give yourself to hit those gaps in the foliage and gather data," Gerhard said.

If you look up in a dark forest environment and you see a glimpse of light coming through the dense canopy, then the laser can get through to the ground where you are standing. The higher density point cloud provided by SPL is a good option to find those small openings between the leaves, penetrate the jungle canopy and map the terrain accurately.

This oblique view of the single photon lidar point cloud shows the Waipi'o Valley on the Big Island of Hawaii.

Single photon lidar also has its challenges, which are just as important to consider when selecting the appropriate lidar mode for a project. SPL collects substantial volumes of data, which can present storage issues, and requires increased data processing duration and resources.

Additionally, unlike some linear mode lidar, SPL100 uses a green laser that can penetrate shallow clear water. This can be a positive addition to a project when there's a need to model subsurface terrain beneath the water along the coastline, as well as lakes and rivers. Such penetration capability depends on water content and clarity; the clearer the water, the deeper the penetration.

However, water penetration also can be seen as a distracter for those trying to delineate water boundaries in lakes and rivers, since such boundaries may be inaccurately placed. For these situations using the SPL green laser, alternate workflows are necessary for delineating hydrologic features.

Summary

Choosing the appropriate lidar mode for any project is dependent on the conditions of the collection and the end use of the data. Single photon lidar worked well for this Hawaii project, as well as a more recent 3,726-square-mile collection across the Missouri River in South Dakota. However, traditional linear mode lidar has been a better choice for a host of other projects with different collection conditions and needs.

"The key is to choose the right technology for the right project," Gerhard said. "By knowing the capabilities of the lidar sensors and choosing the appropriate tool, you benefit the acquisition, the process and the product, which then benefits the needs of the client. That is always our primary objective."

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