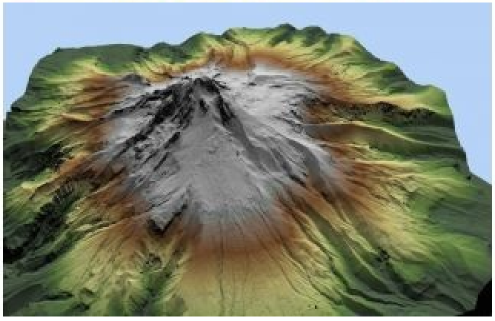
The future of Lidar is critical to the future of our world






What will be the future of Lidar? To quote Abraham Lincoln: “The most reliable way to predict the future is to create it”. So what is currently being created in the geospatial market? This article focuses on Lidar in relation to a number of relevant themes: Lidar technology, open data and artificial intelligence/machine learning (AI/ML).

Lidar technology is developing rapidly, as illustrated by the number of start-up companies to serve the autonomous market which feature traditional mechanical scanning devices, tiny-chip solid-state Lidar units and the emerging FMCW Lidar. The fact that Apple has announced an iPad with Lidar indicates this technology’s arrival in the public domain; whereas it was a challenge to even explain our industry a few decades ago, now many consumers are familiar with the term ‘Lidar’! Moreover, the availability of the technology on a consumer device could be an enabling medium for building information modelling (BIM) and digital twin efforts in the construction world. But discussions surrounding the future of Lidar have many tangents, and technology is just one of them.

Lidar technology

Over the last few decades, the growth and development of photonics and Lidar has been dramatic. We have experienced tremendous improvements in our ability to acquire data. The size, performance and productivity of systems has been transformative for the surveying and mapping professions. The way work is performed and the expectations of the end users are constantly changing. The dramatic improvements in the technology have led to higher pulse repetition rates (PRRs) and miniaturization. This will continue until we reach the limits of Moore’s Law. The term Lidar refers to a system of various components. This complex system has strengths and limitations, as do the laws of physics. As we reach limitations in one area of these systems, we find advancements in related areas. An example of this is the role 5G will play in improving pose estimation in urban centres.

Another example occurs with resolving range ambiguities, which becomes increasingly difficult for single-channel instruments. This impacts system design to accommodate multiple-channel instruments. For instance, each channel is operating at a PRR of today’s standard, but with individual looking directions. As a result, we will see more specialized laser scanners for specific tasks, like corridor mapping and power line monitoring, featuring unique scan patterns for minimizing shadowing effects.

The role of miniaturization within electronics is evident with the class of smaller Lidar systems found on unmanned aerial vehicles (UAVs or ‘drones’). The marketplace is seeing optimized sensors for corridor mapping borne by vertical takeoff and landing (VTOL) platforms. These new systems are lightweight and their orientation results in reduced object shading. They feature high measurement accuracy and high measurement speed, with distinct multi-target capability.

RiCOPTER UAV, equipped with the VUX-1LR laser scanner, in action near the Martinswand, a striking cliff just west of Innsbruck. (Courtesy: Federal Ministry of Education, Science and Research, Austria)

Open data

The impact, value and importance of open geospatial data are now regularly seen. The geospatial market has matured in the past decades to the point that it has become critical to how we view ourselves and manage our world. The dashboards monitoring the spread of the COVID-19 pandemic around the globe are an excellent example. Free data from satellite systems showed impacts of the virus spread, regardless of the veracity of the reporting country’s statistics, such as by demonstrating the greening of the planet during the economic shutdown.

In the Lidar field, we have examples of country mapping where the result is open to all potential users free of charge and without a licence. This has spawned use in remarkable areas. Many cities, counties and states have used this data to improve the management of their districts. Country mapping efforts are seen all over the globe but the EuroGeographics council is a stellar example of this accelerating trend: countries such as the Republic of Ireland and the Netherlands have established country mapping efforts, and Switzerland has gone 3D in its topographic maps.

The NOAA Shoreline Data Explorer to track and monitor storms and sea rise is another example of open data at the service of the population. This example of bathymetric Lidar data is extraordinarily critical for saving lives and property. The impact of smaller UAV-borne bathymetric systems will highlight the ability of local districts to monitor critical wetlands and calculate water loads in rivers and streams to protect us from recurring flooding.

In the USA, the USGS's example of open data is the 3DEP programme. It is used in many of the traditional areas such as transportation and water management. However, the massive amount of geospatial data is free to all and it has been downloaded by many in Silicon Valley to enable them to check their maps and correct their products. This is a big geospatial data utility that is being utilized to assist consumers and companies with correct data.

In the USA, the USGSâ€™s example of open data is the 3D Elevation Program (3DEP). This image shows a 3D model of Mount Hood, Oregon, USA.

Artificial intelligence/machine learning

Lower-level tasks from machine learning such as high-speed classification of point clouds are some of the low-hanging fruit that will facilitate increased productivity. The next level up will bring about the promise of data mining for more accurate forecasting, assessment of impact of changes and the efficient use and allocation of resources.

Over the decades, there has been increasing demand for highly accurate, high-definition and increased-density point cloud data with equidistant point patterns. This is what people call 'high fidelity'. This provides the world with the visualization necessary to manage the ecological impact of populating the planet. Thus, we see the importance of geospatial analytics to the management of our world. It has been estimated that we utilize only perhaps 20% of a typical point cloud. Through the growth of AI/ML, we will eventually be able to utilize all the information that the digital signal processing regime of Lidar provides.

The promise of Lidar is in the accuracy and completeness of the information and the integration of the relevant additional sensor data to provide the high-fidelity visualization that is needed. An example is corridor mapping. Corridors are critical elements to our world. Minor geotechnical hazards can create havoc if not caught in time. The need to be able to 'see' physical assets clearly and correctly is paramount. High-fidelity Lidar systems with appropriate sensor integration will become the standard for providing the visualization needed by AI/ML to routinely find issues and incursions and to avoid disasters.

AI/ML, open data and the Lidar technology itself are just some of the critical factors involved in the future of Lidar for the geospatial industry. We may not be able to predict the future but, in view of all the work being done in the industry, we can see that we are on the right path.

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