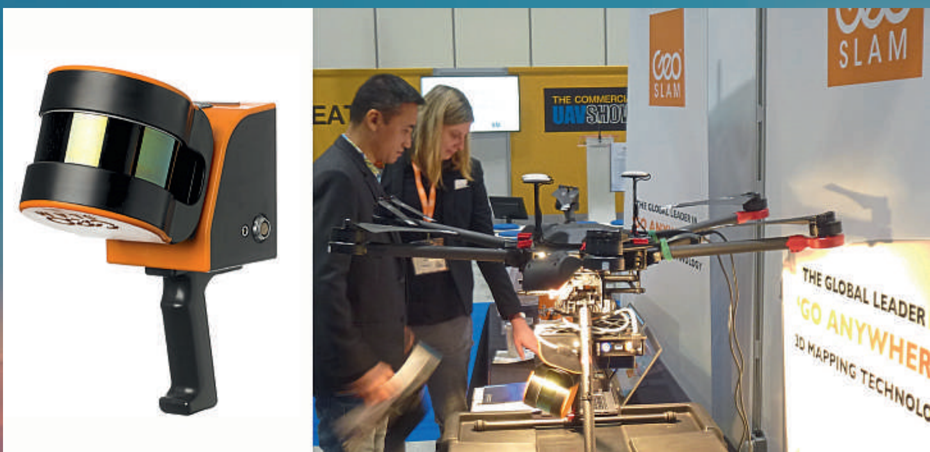
New horizons for airborne LiDAR

The challenges of surveying dense forests, or areas without GPS coverage, are well-known – but the increasing accessibility of hand-held laser scanners is now helping site teams to overcome them, as **Petri Nygrén** explains

The application of LiDAR with fixed- wing aircraft and Unmanned Aerial Vehicles (UAVs) has advanced considerably since I worked on some of the first aerial flights in Finland in 1992. Today's UAVs are capable of carrying a greater payload than ever before, while Airborne Laser Scanning (ALS) systems offer extremely high accuracy over vast, difficult to access and/or dangerous places such as open cast mines and forests. Yet adoption is by no means universal, even if the technology is becoming key to the success of a project in helping to raise safety standards, speed work and boost profitability.

Seeing the wood for the trees

To take forestry as an example, it may sometimes be possible to survey an area of woodland and generate point clouds using cameras mounted on UAVs. The problem is that low-cost cameras normally require good natural illumination (tricky under a dense canopy) and they often cannot capture areas where vegetation is thick.



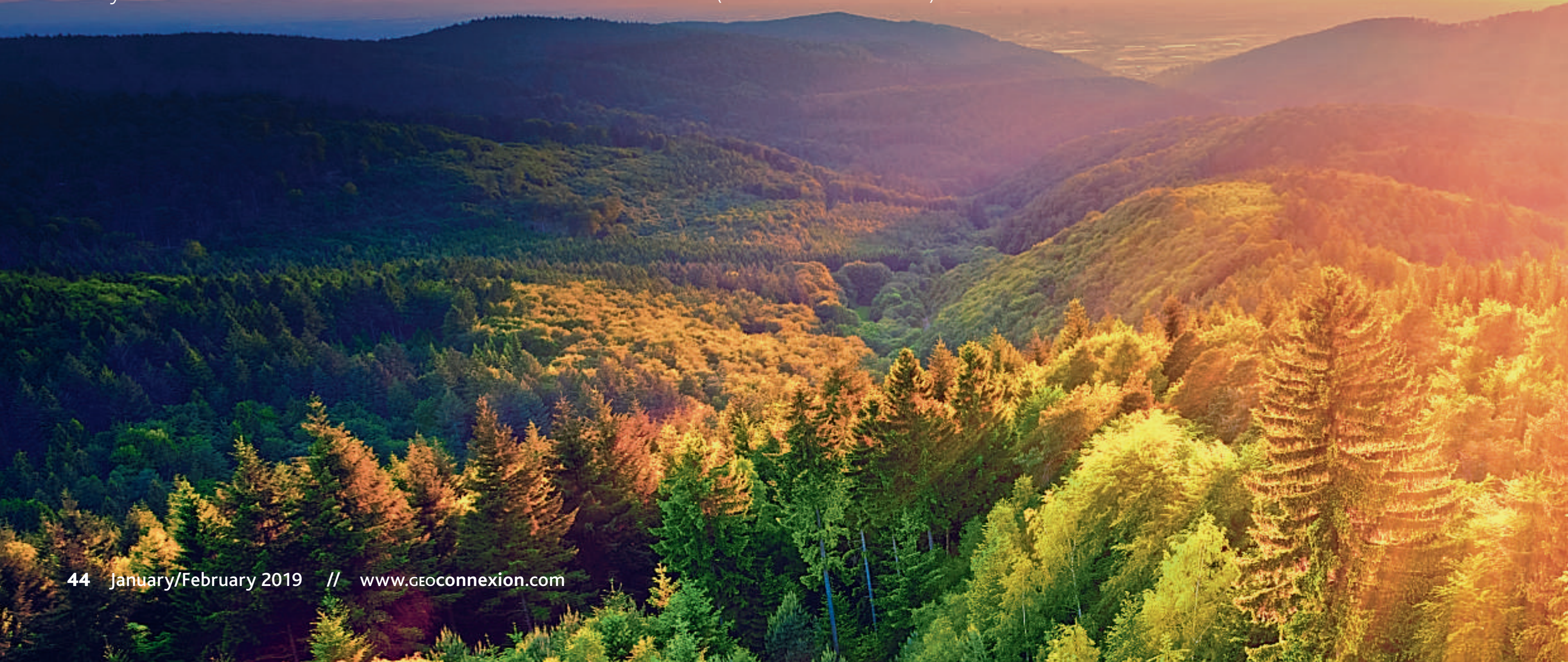
Above left: the ZEB-HORIZON 3D scanner (Photo GeoSLAM). Right: Checking-out the UAV-ready ZEB-HORIZON at the 2018 Commercial UAV Show in London (Photo GeoConnexion)

In comparison, devices using LiDAR can capture hundreds of thousands of points per second, and geospatial and forestry specialists are therefore now able to create detailed images of the forest canopy, floor and individual trees (including the species as well as trunk characteristics and growth) in millimetres.

Yet some managers on smaller projects are reluctant to invest in UAVs with LiDAR capabilities, often because of the perceived initial costs and the potential risk involved. Instead, they might rely on traditional surveying methods such as terrestrial laser scanners that have limited mobility and coverage in large spaces.

Modern mobile mapping devices have never been more accessible and can mounted on UAVs and vehicles, as well as being handheld or carried in a backpack. As an example, computer science students from Maynooth University in Ireland deployed a GeoSLAM mobile mapping system mounted on a UAV for environmental and coastal mapping projects, and intend to use the system in many more projects involving agriculture, forestry and urban mapping.

Some other modern mobile mapping systems might offer an unprecedented level of accuracy, yet their application can



be limited when working in areas with difficult terrain, such as forests, and/or where GNSS coverage is poor, such as in buildings or underground in tunnels or mines.

Rising to the challenge

A SLAM (or Simultaneous Localization And Mapping) based LiDAR solution is one of the most effective technologies to rise to this challenge, since site teams can rapidly scan indoor spaces by walking around with the device in their hand. As well as driving down the time it takes to complete a scan, a system such as GeoSLAM can be operated by anyone, so measurements can be taken as frequently as needed, without the need for time-consuming training.

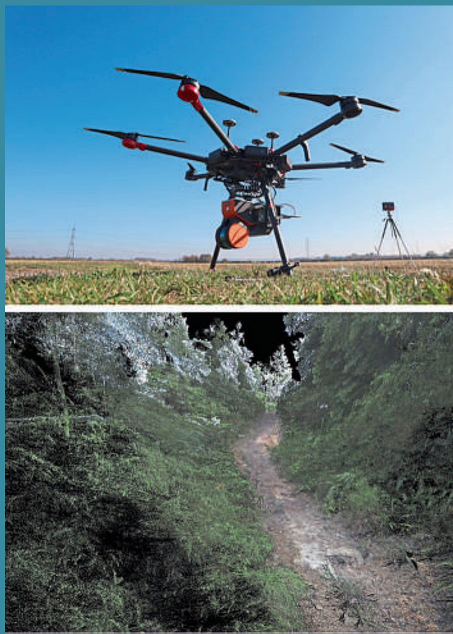
Researchers from the University of Leicester also used GeoSLAM's mobile mapping devices using SLAM when they set out to find more efficient ways of estimating biomass and carbon in the man-made tropical forest at Cornwall's Eden Project.

Simply by walking around an area, the team captured point cloud data that was converted into 3D volume-based plots, that allowed them to establish the carbon densities and above-ground biomass of different types of tropical forests.

It was something they could achieve without employing specialist surveyors, and it took a fraction of the time to complete, compared to taking multiple static scans. Furthermore, the researchers now have a detailed dataset that contains information on any type of forest and which is also readily available to scientists working on similar projects.

Scanning the HORIZON

It's fair to say that historically, GeoSLAM's work has primarily focussed on developing solutions for the rapid scanning of indoor spaces. However, in response to demand for longer range solutions, that can be used outdoors on



Top: With a range of 100m and payload of 3.7kg, the ZEB-HORIZON lends itself to a wide range of UAV surveys such as forestry (below) where its collection rate of 300,000 points per second, at an accuracy of 1-3cm, achieves survey-grade results. Photo/Image: GeoSLAM

UAVs and are capable of scanning at speed, the company launched its ZEB-HORIZON at last year's INTERGEO expo in Frankfurt.

While other scanners in the ZEB family are well-suited to capturing areas at a range of up to 30m, such as inside buildings or railway tunnels, the ZEB-HORIZON can scan subjects at a distance of up to 100m, either as a handheld device or mounted aboard a UAV. The scanner emits 300,000 points per second, enabling highly-detailed feature detection even at height. Weighing around 4kg, and with no need for an additional GNSS/IMU unit, it also keeps payloads (and therefore project costs) down too.

Like other LiDAR systems, the ZEB-HORIZON creates a point cloud from an initial laser scan before automatically extracting features such as trees and buildings. Additional features are captured every second as the scanner flies to a new location – but unlike other systems, the SLAM algorithm recognises identical features and automatically matches them to the previous scan. This means operatives don't have to manually match scans during processing ... a big time-saver. Once this is completed, the device updates a new fix in its trajectory and begins a new scan.

Enormous potential

In other industries, SLAM is playing an important part in the evolution of driverless vehicles, as well as opening up new possibilities for autonomous navigation via UAVs to aid automatic obstacle avoidance.

Although the ZEB-HORIZON is only just starting to be deployed, its potential was evident in two test flights conducted at a site in Nottingham. The first, lasting just four minutes, was conducted at a height of 35m and, when measuring a building roof, captured a point density of between 1,000 and 3,000 per metre squared. Even during the second flight, conducted at an altitude of 75m, a point cloud density of 1,000 to 2,000 per metre squared was achieved.

This new generation of airborne SLAM has enormous commercial potential across a wide range of industries – and, if feedback from INTERGEO is anything to go by, we can expect to see its application adding value to projects in the very near future.

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