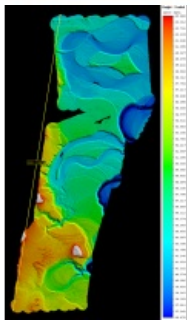
Finnish Geospatial Research Institute Expands Airborne Toolbox



The Finnish Geospatial Research Institute (FGI) has recently added the RIEGL VQ-840-G airborne laser scanner to its impressive collection of sensors. FGI innovators are true scientists, moving the 3D industry forward in new ways that will prove very interesting to watch. The new low-altitude bathymetry sensor will be employed for surveys in areas of shallow water such as wetlands, riverbeds and coastal areas.

In the coming year they will be teaming up with other researchers around the world to work on projects involving forest health, wetlands restoration, glacier change detection, optimization for autonomous vehicles and modelling for autonomous vehicles and smart cities.

With the addition of the new RIEGL VQ-840-G, FGI will be able to add more depth to the scientific techniques in its portfolio in two distinct ways: pairing it with other airborne scanners to obtain information in multiple wavelengths (visible and infrared), and obtaining bathymetric datasets of shallow water bodies such as river beds, coastal areas and peatland drainage.

RIEGL VQ-840-G Lidar scanner mounted on a RiCOPTER-M.

Scanning in Three Wavelengths

FGI plans to pair its new VQ-840-G laser scanner with others in its kit: RIEGL's miniVUX-1DL, the VUX-1HA, and the VQ-480-U to conduct multi-spectral wavelength collections.

FGI Research Professor, Dr Antero Kukko, is creating a custom platform that will hold three different sensors and can be mounted onto a helicopter. The operator and scanning equipment can be deployed to whatever location is desired, and then enlist the services of a local helicopter flight service. In this way, within one singular flight there will be three Lidar scanners collecting high-resolution 3D data simultaneously in three distinctly different wavelengths.

Why three wavelengths? Each wavelength offers different qualities for scientists including enhanced 3D geometric and radiometric properties, scattering or echo properties of each pulse and reflectance.

Dr Kukko explained: "These characteristics have typically been collected through passive imaging by remote sensing or hyper-spectral imaging. But what we hope to do now is to remove some of the potential error sources such as sunlight dependency or elevation or object geometry variations. With Lidar scanning simultaneously in three different wavelengths we can even out some of these factors." He continued: "A single wavelength is pretty narrow so with only one sensor's wavelength it's a somewhat limited sample. When you add more wavelengths you can use that extra data to make more advanced characterization of surfaces/objects being measured. It gives you more tools for interpretation."

As an example, FGI plans to use this three-scanner system on projects like determining forestry health and documenting tree growth patterns. The data from the three scanners will capture information from the canopy to the ground and will provide information to researchers on characteristics including: tree species classification, rock formations, moss and subdominant and under-vegetation, wetness of the ground, slopes, impacts of climate change and impacts of insects or disease.

FGI conducts research globally with scientific institutions, academia and practioners. Antero Kukko and colleagus of the Institute of Mountain Science, Shinshu University in Japan, collaborating on advanced precision forestry research using modern kinematic and UAV-Lidar technologies. (Image courtesy: FGI)

Governmental agencies and private forestry leaders are eager to receive this wealth of information. Kukko said: “We want to demonstrate and foster applications of this data, and further improve the efficiency and spatial coverage of this type of airborne laser data. In Finland there exists an open source of free and accessible nationwide laser data, and authorities are using this data on a daily basis. So the information is already available but we want to continue to improve it. For instance, if we can perform a tree growth analysis through the years, from season to season, it could be valuable in many ways. We can combine Lidar data with field sampling of the nutrients and soil moisture for a more complete understanding of the forest. This multi-wavelength technique has applications beyond what we can imagine today, but two obvious uses are predicting future forest growth or how it might respond after a fire.”

Bathymetric Scanning of Shallow Water Bodies

The VQ-840-G is a low-altitude bathymetry sensor with a 40-degree field of view (FOV) from two different angles. Viewing water bodies from different angles increases the likelihood of Lidar penetration beneath the water’s surface and towards the bottom. Another unique feature of the sensor is its ability to capture the full waveform of the outgoing pulse. This allows for waveform stacking and also increases the depth of water penetration. The system can be paired with a camera or single point range finder.

A key application planned for FGI’s new VQ-840-G is to use it for bathymetric research in areas of shallow water such as wetlands (swamps, marshes and bogs), riverbeds and coastal areas.

FGI has been able to obtain underwater surface data using sonar obtained via boat. But shallow areas such as marshes, riverbeds or near coastal shorelines are harder to capture. Professor Kukko gave an example: “Rivers, a natural habitat for salmon in the Finnish arctic, are quite shallow so there is too little water for the survey boats to float over them. By using the green wavelength of the VQ-840-G we should be able to fill in the missing information and complete these models.”

FGI’S Planned Bathymetry Projects

Wetlands

A future project to watch will be the creation of a detailed geological survey including measurements of drainage areas in the wetlands of Finland’s forests. “The forests have many man-made ditches that are diverting water, hummus and nutrients, and affecting the ecosystems in Finland and the Baltic Sea. There is a restoration effort underway and detailed elevations and maps will be quite useful,” said Dr Kukko. This strategy could be shared with other governments around the world with similar wetland areas when they are planning a restoration.

Rivers

Arctic rivers have a heavy discharge when the snow melts, but more of the time it is quite shallow and the water is more clear. Kukko said: “Turbidity of the water has an effect on how deep we can see through the water body. We recognize that there are limits to what we can see with the VQ-840-G, and we want to understand what exactly is possible with this equipment through experimentation. Having the equipment readily available when the water is more clear will make capturing data about these rivers possible.”

Coastal

Finland has 1,250km / 780 miles of vastly diverse coastal geography. There are a lot of shallow sea areas in the west, and areas in the north that have and continue to experience land uplift – a post-glacial rebound that should be monitored. There are areas off the southern coast that are typically quite muddy but have periods of water clarity. These coastal areas are all important for their biodiversity, as well as their fisheries and seafaring navigation. With the VQ-840-G FGI will map these areas at times when there is lower turbidity, at greater frequencies, or after a major weather or other event. These data sets will inform researchers of the health of both sea and inland, and analyse and predict wave patterns.

Axel Heiberg Island, in the Canadian Arctic, provides an intriguing but challenging glacier environment for planetary analog and permafrost studies. Isolated sites can be accessed by helicopter to perform high-resolution terrain mapping, using the FGI-developed Akhka-R4DW backpack system (based on RIEGL's VUX-1HA and miniVUX-1UAV scanners) to implement two-wavelength scanning. (image courtesy: FGI)

2021 FGI Research Plans Elsewhere

FGI has teamed up on research projects in Canada, United States, Japan, Sweden and numerous European countries. Many of the projects focus on improving forest and vegetation information for structural analysis, quality of the timber, forest health and forest fire risk assessments.

In addition to forestry applications, FGI will continue to be involved in geomorphology research and characterization of diverse terrain features like volcanic landscapes, fluvial and coastal systems and glaciers using high-resolution 3D data. It also works with scientists who are doing planetary studies to interpret other remote sensing data such as satellite radar.

An exciting project planned for late 2021 is Antarctic sea ice and glacier measurement and surface modelling that includes the roughness of snow and ice, snowpack and other glacier topography that will be compared with data collected by NASA’s ICESat-2 (ice, cloud, land elevation satellite and in-situ sample, and snow albedo data). This project will likely be performed using the RIEGL miniVUX-1DL on a drone for wide-area topography and kilometres-long transects over the snow pack and sea ice.

In the field of autonomous driving, FGI has plans to continue its research on the using Lidar technologies for perception, autonomous

navigation and high-definition mapping of road and urban environments.

As a part of a National Land Survey of Finland, FGI conducts research and development of automated data collection and processing technologies and methodologies for future operational mapping and monitoring purposes.

Lidar imagery of a section of the Pulmanki River in Finland, showing how it has meandered over the centuries.
