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LIDAR news

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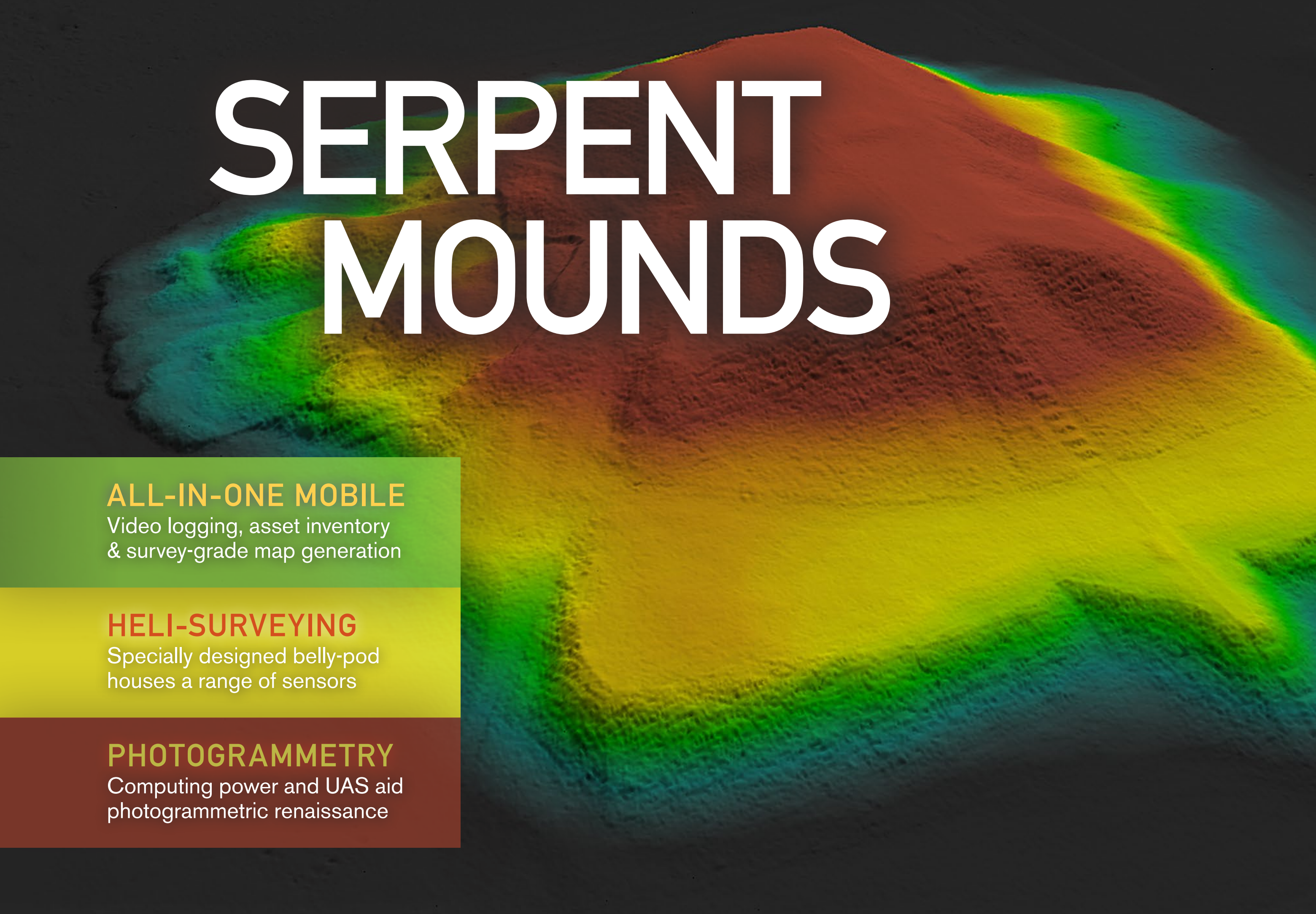

SERPENT MOUNDS

ALL-IN-ONE MOBILE
Video logging, asset inventory & survey-grade map generation

HELI-SURVEYING
Specially designed belly-pod houses a range of sensors

PHOTOGRAMMETRY
Computing power and UAS aid photogrammetric renaissance

Riegl LiDAR scanner with Inertial Measurement Unit and 36 MPixel Camera installed into the Belly Pod under Squirrel helicopter.

SURVEYING POWER LINES IN ANGOLA

Power outages caused by damage from trees and other vegetation are a common occurrence in many parts of the world. The August 2003 blackout that affected 50 million people in the Northeast United States and Canada was attributed to tree contact with transmission lines and ultimately led to changes in US legislation relating to vegetation management. However this problem is not isolated to the developed world.

In late 2013 Angola announced plans to boost electricity production fivefold in a bid to attract investment in industry to the country. Africa's second largest crude oil producer Angola, located on the south west coast of Africa, currently suffers daily power outages as the country recovers from a long period of civil war. The state wants to double the number of people with access to electricity, to 60 per cent of the estimated 21 million people in 12 years and the goal is to have an installed capacity of 9,000 megawatts of generation capacity by 2025 compared with a current capacity of about 1,800 megawatts.

Jose Salgueiro, director of studies, planning and statistics at the Ministry of Energy and Water, said in an interview at the time, "Everything is planned to have the electricity there because it's the main way to say Angola is open for business," speaking in Luanda, the capital. "The promise of more power will attract more investment."

This public statement of intent has prompted one national power company Empresa Nacional de Electricidade (ENE) to assess the state of the transmission network and the proximity of its infrastructure to vegetation. Working with South African-based mapping and surveying specialist GeoM 1,500 kilometres of detailed LiDAR measurements were captured.

BY FAITH **CLARK**

Base station set up

The laser scanned point cloud will be used in a number of ways; the immediate requirement being for vegetation clearance analysis.

By identifying serious occurrences of vegetation encroachment preventative action can be taken to prevent power outages. The data will also be used to support maintenance and upgrade programmes with engineering of the power line to consider how different power loadings affect the sag, and therefore the clearance to vegetation and buildings. In time a GIS database will be established using the data which will allow for centralised management of all engineering works.

The power company also had a requirement for additional data including high resolution aerial photography, meteorological and thermal measurements.

The Physical Challenge

Traditional LiDAR configurations tend to include a dedicated survey plane specially equipped with a range of sensors that can be deployed, subject to flight permissions from an air base in the vicinity of the survey area. This allows for regular refuelling and a base for a ground support team including field surveyors. Due to the remote location of much of the power line network this was a luxury that was not available to the GeoM team.

In order to complete the airborne element of the data capture aspect of the project GeoM utilised a specially designed belly pod. Mounted on the underside of a Eurocopter AS350 B2 helicopter the pod is designed to securely house a range of sensors that are transported to the survey area by the ground support team. All of the equipment, including the pod itself which can be dis-assembled into a flat package and packed into cases small enough to be checked in as normal airline baggage. This physical characteristic allows for rapid mobilisation to virtually anywhere in the world.

The project methodology and equipment selected for data capture was specially optimised to only require a 4 man team; consisting of the pilot, system operator and two surveyors, with no additional support from the power company. There were two distinct

Ground control point mark in the field under the powerlines

elements of data capture with the process clearly segmented into ground survey and airborne capture enabling around 80km of power line to be documented each day.

On the Ground

With at best poor road access to power lines, and at worst no access, the ground surveying team were transported each day using the helicopter. Preparation for the day's surveying including placing of base stations and marking of ground control points which was the first task and the most time consuming. Other ground survey tasks included setting up the weather station and taking spot temperature readings for the wires.

During the LiDAR survey differential GNSS techniques were used. This required a static receiver on the ground—the base station, and a moving receiver in the helicopter. For good accuracy the maximum distance between the two should be no more than 20km meaning that for each day of airborne data capture 2 base stations needed to be placed. To further ensure the accuracy of the survey, Ground Control Points were marked directly under the power lines at regular 20km intervals. These GCP were accurately measured using differential GNSS techniques from the base station.

During the surveying of the GCP's spot temperatures of readings of the power lines were taken using a thermal camera. Readings were taken at the point where the wire was closest to the ground and the data was supplied as a database file of co-ordinates and temperatures as a CAD file. These readings will be used by the power company engineers to model sag on the line for existing power loading and to enhance the LiDAR measurements.

A portable weather station was also set up to measure the ambient weather conditions for each day of the survey. Measurements included temperature, wind speed, wind direction, air pressure and humidity. These data were supplied to the power company in a database format.

Up, up and away

The second part of the daily survey mission was the actual LiDAR survey and concurrent capture of high resolution photographs. The data capture system, mounted in the belly pod of the helicopter, included a Riegl LiDAR scanner with Inertial Measurement Unit and a 36 MPixel digital camera.

Flying at a speed of 22 metres per second (about 50 miles per hour) the pilot used the terrain to maintain a constant height of 100 metres above the ground. The system operator was in control of the laser scanner and camera and worked with the pilot to help maintain the correct flying height.

Once the day's data capture had been completed—on some days this was two missions equalling 160km, the helicopter collected the ground survey team and equipment before returning to the operations base.

Data crunching

An initial check of collected data was undertaken each day to ensure coverage and quality of the data. This allowed for resolution of any issues while the team and equipment were still in the locality.

The survey data, both point cloud and photography, was processed for a corridor of 100 m along each power line. The raw laser scanned data was georeferenced and the ellipsoidal elevation corrected to orthometric height. A 5 cm positional accuracy was achieved by using a combination of precise point positioning (PPP) and differential GNSS. The average density of the point cloud was approximately 30 points per square metre.

Classification of the point cloud was undertaken using well established algorithms into the following classes: ground, low vegetation, medium vegetation, high vegetation, towers, wires, danger objects and buildings. Specialized software was used to automatically extract CAD lines for the power line catenary wires although the point at which the ends meet the tower were manually checked.

The photographic images, captured every 3 seconds during flight, were geometrically corrected for lens distortion and orientation before being georeferenced and combined to produce orthorectified image files. Colour balancing was also undertaken to remove major variations between adjoining images. The resolution (ground pixel size) of the digital images was 5 cm with each image 4,000 x 4,000 pixels delivered as GeoTIFF format files.

GeoM completed the data capture element of the power line survey in December 2013 with full delivery of data to the end client in January 2014. In total 1,518 km of power lines were surveyed with accompanying temperature, weather and photographic records. The data is now with ENE who will be using it to support maintenance and upgrade programmes.

Main operating base at Hydro Electric plant

The major success of this project to date has been in the innovative configuration of fairly traditional surveying equipment. LiDAR is commonly thought of as the 'go to' technology for power line mapping and as such is regularly used in North America and across Europe. The challenges of remote locations coupled with poor access for ground workers in Angola meant that GeoM needed to think out of the box both in terms of system configuration and working practices.

The design innovation demonstrated, coupled with a well thought out and documented project plan, has proven LiDAR surveys can indeed be the solution of choice for power line mapping —just about anywhere in the world!

Faith Clark is an expert in marketing communications with specialist knowledge of geographic information and systems, mapping and the use of technology in the public and private sectors.

Classified point cloud coloured by intensity in 3D view

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