On the line

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A major aerial mapping survey is helping prevent damage to overhead power lines and avoid blackouts, writes Faith Clark

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According to a certain distribution network operator (DNO), 1 of the companies responsible for delivering electricity to our homes and businesses, there are 3 main causes for unplanned power cuts: weather, other people accidentally damaging power supplies, and trees or vegetation.

Severe weather can cause damage to overhead and underground power lines, debris and trees falling on power lines can pull them down, water can get into underground electricity cables and lightning can strike essential infrastructure.

Vegetation infringing on the overhead network is one of the major causes of power cuts in the UK. Even the day-to-day effect of a tree brushing against a cable is thought to be one of the most common causes of power blackouts. Because of this, all electricity distributors are required by the Electricity Supply and Continuity Regulations to keep vegetation clear of overhead lines.

The problem

Two of the main challenges facing electricity network operators are the physical scale of the overhead network, coupled with its often remote or inaccessible location, and the changing nature of the problem as vegetation grows.

UK Power Networks , which delivers electricity to over 8 million customers in the South East, East Anglia and London, has nearly 60,000km of overhead lines. In the past, this network has been continuously monitored on foot by surveyors. In a task that rivals the continual painting of the Forth Road Bridge, surveying the entire network normally took around 3 years, and had to be undertaken as quickly as possible to prevent the data being out of date by the time it was all collected.

Testing technology

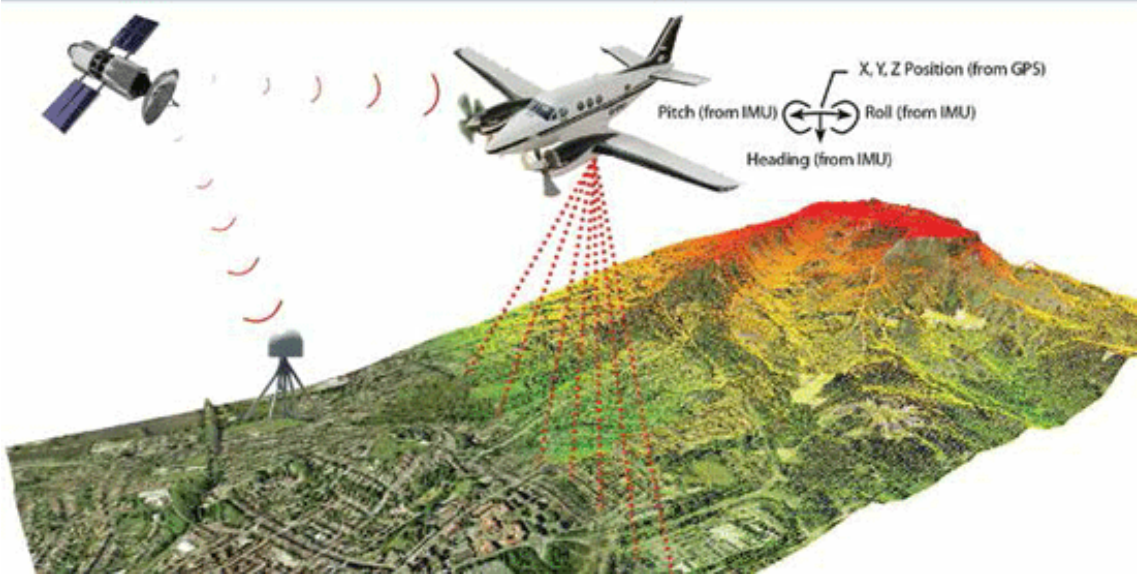
In 2013, UK Power Networks embarked on a project backed by the Office of Gas and Electricity Markets (Ofgem)?s Innovation Funding Incentive, to establish whether a combination of high-definition satellite and light detection and ranging (LiDAR) data could be used to survey vegetation infringement on the high-voltage overhead line network with sufficient accuracy to enable a risk-based approach to tree cutting. The trial was carried out in 2 areas of the power network, representing about 1% of UK Power Networks? high-voltage overhead lines.

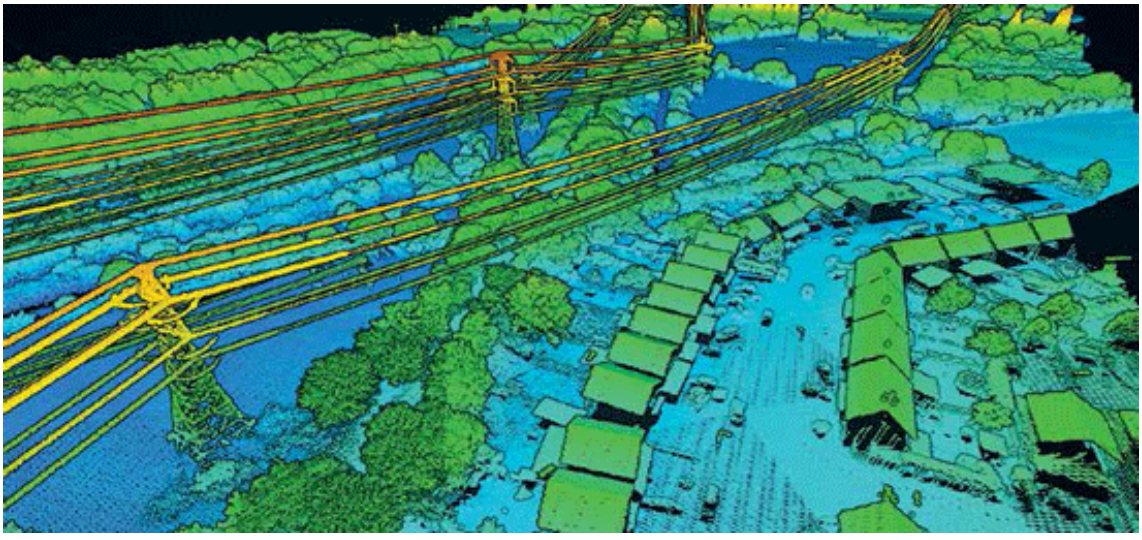
UK Power Networks found that LiDAR could reduce the need for field-based vegetation surveys by up to 80%, while providing more accurate and objective assessment of the

tree-cutting workload and cost. The trial also identified potential savings of up to 20%, reduced risk to field workers and less impact on landowners. Furthermore, low-hanging conductors could be identified by the remotely sensed data, improving safety through detection and disconnection.

UK Power Networks entered into a contract with aerial mapping company Bluesky and agricultural and environmental consultants ADAS following a competitive tender. The project involved high-resolution aerial photography and LiDAR measurements of UK Power Networks? entire overhead lines in the East and South East of England regions at high voltage and above, covering some 34,000km2.

Bluesky survey planes covered the project area in just over 3 months; operating to tight deadlines and specifications in challenging weather conditions and under strict air traffic control restrictions. Bluesky captured in excess of 80TB of raw data, made up of millions of individual height measurements as well as around 310,000 aerial images.





Seeing the wood for the trees

The raw data was analysed to create a spreadsheet including details about the high-voltage network and a risk assessment. Data covered the proximity and direction of vegetation and the distance between overhead lines and vegetation in diagonal, vertical and horizontal perspectives.

Vegetation risk levels, from very high to high, medium and low, were computed, according to proximity and voltage, and the linear extent of vegetation along each span to calculate the risk level for each. Customer numbers were also factored in to assess the impact of potential outages and inform cost?benefit analysis. UK Power Networks has used these results to prepare a 3-year tree-cutting programme, which will be refreshed every 2 years and prioritised according to the potential risk to customers from power outages.

Bluesky also created a virtual reality representation providing a real-world view of the network and its surroundings. The 3D desktop portal allows UK Power Networks staff to explore the network and analyse data without leaving the office.

Moving forward

The tender process reduced anticipated survey costs by an estimated third and, as technology evolves, it is expected that data collection costs will fall further. The project has also enabled a reduction in UK Power Networks vegetation management costs by around 20%, equivalent to around ?5m annually, as well as ensuring that tree cutting is targeted at higher-risk spans to get the best value from the ?19m annual tree-cutting spend. Contract tenders have also provided more accurate quotes for jobs to be undertaken, offering additional savings on unexpected works.

An airborne LiDAR, such as the one used by Bluesky to map the UK Power Networks overhead line network, consists of a single laser emitter coupled with a receiving device. The laser produces an optical pulse ? a beam of light ? that is transmitted to the ground and then reflected, either by the earth?s surface or an object on the surface, and returned to the receiver.

UK Power Networks expects to see significant and repeatable improvements in the field over the 3-year revised tree-cutting programme. Evidence of a reduced number of overhead line faults where cutting has taken place has already been collected and is being analysed. Unexpected benefits from the project include accurate geographic referencing of pole and tower supports, improved span length, and therefore overall network length, and measurement and identification of data anomalies between different asset register systems.

The results are also being used to carry out an audit of previous contract compliance. The objective is to review both the scope and effectiveness of past tree-cutting activities and recover, if appropriate and fully supported by evidence, costs that have already been incurred. UK Power Networks has also invited tenders for a similar project across all voltages on the overhead line network and is exploring other aerial surveying activities such as condition-monitoring patrols and conductor height assessments.

The receiver records the time of travel for the pulse and the intensity of the light returned. As the pulse is travelling at a known speed ? the speed of light ? the travel time can be accurately converted into distance or range. This laser range is combined with the known position of the sensor, from the on-plane GPS, and the laser orientation, from an inertial measurement unit, to calculate accurate x, y and z ground coordinates for each laser pulse.

An airborne laser working at 500MHz can fire up to 500,000 pulses of light per second. As modern LiDAR systems can record multiple returns from the same pulse, this greatly increases the detail obtained and therefore the volume of data collected.

Bluesky operates an Orion M300 from Optech, the world?s smallest complete LiDAR mapping system, which includes multi-pulse technology and an effective ground sampling rate of 300kHz, significantly increasing the efficiency of data collection and the density of collected points.

Faith Clark is a technology writer and marketing consultant at Marketing Edge

Further information

- Images ? Bluesky
- Related competencies include Mapping , Legal/regulatory compliance , Remote sensing and photogrammetry
- This feature is taken from the RICS *Land journal* (March/April 2016)