CASE STUDY

Angry birds at altitude

Tasked with a large and topographically challenging survey near Quito in Ecuador, AOC Ingeniería used an eBee for its data collection. But the terrain wasn't the only problem the team faced…

The effectiveness of traditional surveying can sometimes be limited in areas of complex topography, making it difficult to access the locations required for effective data collection. By contrast, an eye-in-the-sky UAV approach can gather point clouds full of data, at roughly equivalent accuracy.

This aerial advantage is one of the reasons why Hazen and Sawyer / Pi Épsilon – the main contractor for a government construction project outside Ecuador's capital, Quito - outsourced its surveying work to AOC Ingeniería, an engineering services company with several projects' worth of drone mapping experience. The job? To run a large topographical survey to the North of the city, the potential site of a new wastewater treatment plant.

"We've been using drones for a year but this project was easily our most testing, even before the bird attacks, because the site creates lots of topographic challenges," says Juan Pablo Solorzano, the Director of Transportation in AOC Ingeniería's Geomatics division. "At this site there are very few flat areas, and the areas that exist contain some deep gullies, so any location decision must consider the terrain very carefully."

The client required detailed cartography at a scale of 1:1000, which translates to a horizontal accuracy of 0.3 m and vertical accuracy of 0.5 m. "This is what we were aiming at with the GSD we chose, but in reality the results were nearly as good as to achieve a 1:500 scale accuracy," Solorzano says.

Topographical challenge

The total area to survey, situated between 1,600 and 2,600 metres (5,250 – 8,530 ft) above sea level, came to 40 km^2 (15.4 mi^2), at the larger end of the spectrum for mapping drone projects. "Our coverage area was so large because the project is huge, with the slightest change in location of one component, such as a tunnel, immediately affecting the rest," Solorzano explains. "Plus, with so many accessibility issues, one of our most difficult tasks was to locate ground control points, and by flying slightly larger areas we could identify more potential GCP positions."

Challenging terrain rendered terrestrial surveying techniques impractical if not impossible.

senseFly
a Parrot company

The team flew a senseFly eBee UAV, an automated drone system that carries a 16 MP IXUS still camera. AOC Ingeniería originally chose this drone for its ability to operate efficiently in the Andean region's high-altitude, low-density air. However its landing accuracy of 5 m (16 ft) was also helpful for the Quito job due to the site's limited number of landing spots.

"When planning flights we specified a GSD of 8 cm per pixel, which equates to an average flight altitude of 300 metres. We also generated our flight plans based on SRTM elevation data, to retain a consistent GSD, then double checked these in 3D using Google Earth. All in all we carried out forty flights, each lasting 30-35 minutes and covering around one square kilometer (0.4 sq mi) per flight," Solorzano explains. "Due to the terrain interrupting the ground modem's signal, a small number of flights even went beyond radio range – just for a few seconds – where we relied on the flight plan and its approximate terrain feature."

One of the team's 40 flight plans, shown in 3D in Google Earth.

Attacked from above

While Solorzano was aware of the geographical challenges however, he wasn't expecting animal interventions.

"Our drone was attacked several times by hawks," recalls Solorzano. "This was the first time we've experienced this, although we now understand these attacks are fairly common. We think they attacked because it was breeding season and we were flying close to their nesting areas."

The first attack, completely unexpected, caused the damage. The hawk hit the UAV's battery compartment first, but the drone could still continue. However the bird then returned and grabbed the UAV's wings. "These detached and caused the drone to crash, and we never recovered the wings or its propeller," Solorzano says. "However we did find the body. We repaired its scratches by applying a little glue to the eBee's foam and we disposed of its damaged battery. Then back at base we could replace the wings, but we needed our backup drone to continue the same day."

The suspected aggressor was a so-called Roadside Hawk.

Following the hawk attack, the eBee's central body and electronics were found intact, but its propeller and wings were never located.

Aware of the threat, Solorzano used the UAV's emergency manoeuvres – activated via its flight control software – to steer clear of further attacks. "The hawks would fly above the drone, close their wings and dive down, but we noticed that once they'd set their target they couldn't change it easily, so performing fast climbs was enough to avoid being hit," he says.

Multiple flights took place on each of the project's ten flying days, with the team processing imagery back at the office as batches of photos were delivered. "Most of our flights were processed overnight, although merging sometimes took longer. After merging, we extracted 1.2 square kilometre blocks with overlap, each taking three to five hours," Solorzano says.

The team employed a range of third-party software programs to perform feature digitisation, point cloud filtering and manual editing, creating its final digital terrain model (DTM) from the filtered point cloud using a mix of automated and manual classification to filter out buildings and vegetation. "For contour generation we used ArcGIS to obtain rasters from the point cloud, then we smoothed these further using SagaGIS," Solorzano adds.

Project workflow

01 Field visits
02 GNSS GCP setting
03 Temporary GCP locations using targets
04 Flight planning
05 Flight execution
06 Initial image processing
07 Merging
(GCP & manual tie point locations)
08 Area extraction (1.2 km^2)
09 Feature digitalisation (MicroStation)
10 Point cloud filtering (LAStools) & manual editing (ArcGIS)
11 DTM filtering to improve contour generation (SAGA GIS)
12 GIS database creation (ArcGIS)

Real-world results

This UAV approach saved the client a significant sum and they received their results much more quickly than would have been possible in the past. Surveying the area using total stations for example – as AOC Ingeniería might have done a year previously – would have taken at least four months, Solorzano says, and used four times as many staff, to come close to the amount of raster data generated by one drone.

"The amount charged the client was approximately one-fifth of what we would have charged using conventional surveying, plus in some areas, such as gullies, our data was considerably more precise," he confirms.

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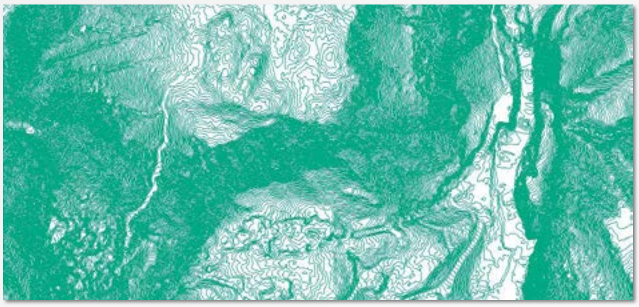
A close-up of the project's final orthomosaic.

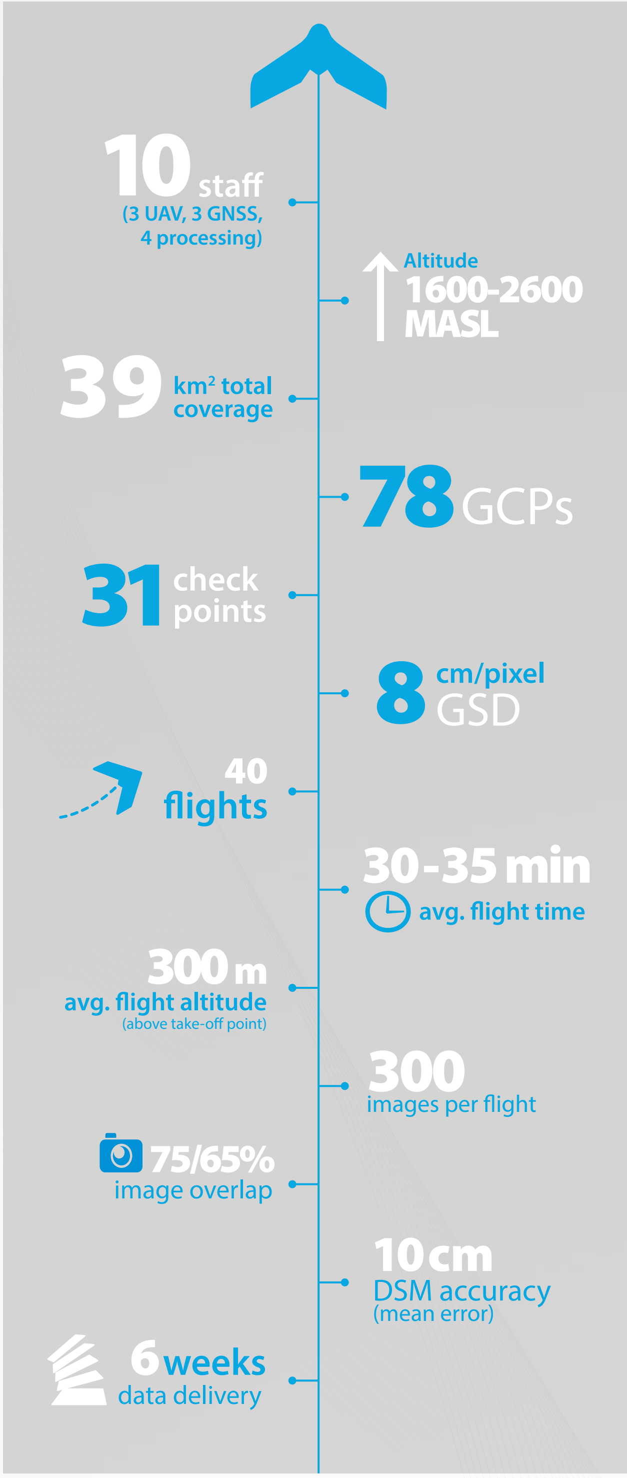
The team's full orthomosaic, overlaid on its 3D DTM of the site.

The full digital terrain model, shown in 3D.



The final cartographic map of the site showing its contours.

PROJECT STATISTICS



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