A PLACE IN THE SUN

AKUO ENERGY WANTED TO SPEED UP THE INSPECTION OF ITS SOLAR PANELS. BUT WOULD A UAV BE CAPABLE OF FLYING PRECISELY ENOUGH FOR LONG ENOUGH TO MAP OUT ITS ENTIRE FIELD? KRISTA MONTGOMERY, ROMAIN JALLAT, YOANN JOBARD AND ANTONIO D'ARGENIO FIND OUT

Seeking an alternative way to inspect its photovoltaic (PV) fields, French independent renewable-energy producer Akuo Energy began looking to one of the newest methods now available: UAV inspection. The company had previously been inspecting each solar panel individually, using a handheld infrared (IR) camera. For each annual inspection, this took two employees around four days of work walking through the farm and capturing an image of each panel with the camera.

Akuo wanted a method that would reduce the amount of time and money spent on inspection, in addition to increasing detection of damage and hotspots in its panels. It benchmarked several UAV-inspection companies for the job, but noted that most only had a small amount of knowledge in thermographic inspection of solar plants. It ended up selecting an aerial surveillance company called Air-Marine to evaluate the efficiency of its fields. Air-Marine had previous experience in UAV and IR inspection and was flexible in developing new processes to fit Akuo's needs in follow-up thermographic inspections.

This relatively new method of solar field inspection has a workflow that includes the use of UAVs, an integrated visual and thermal sensor solution, and photogrammetric software. Akuo chose one of its solar farms in France to be the first it tested with Air-Marine's workflow. This particular farm stretches over 30 hectares of land, with an installed power capacity of 24MW produced by more than 75,000 solar modules. Regularly inspecting these solar field panels is in the owner's best interest: ensuring that any defects, or potential defects, that could cause a reduction in solar power yield are quickly found and repaired.

For an inspection over a large surface area like this solar field, a UAV needs to be able to fly relatively long periods of time without stopping or running out of battery. It also needs to be very reliable, in order to fly over highly valued assets such as solar panels, and capable of completing very precise flight plans.

The MD4-1000, a vertical takeoff and landing Microdrones UAV was chosen as it is capable of flying up to 88 minutes non-stop and can carry a payload of 1.2kg.

Data acquisition and processing

For data acquisition, the quadcopter flew two successive flights over the PV field, using the drone's waypoint navigation software. The first flight carried a Sony Alpha 7 full-frame camera, capturing pictures to

Akua Energy's solar farm covers 30 hectares of land and has more than 75,000 solar modules

create a georeferenced map of the area; the second, low-altitude, low-speed flight was conducted carrying a mT-Panoptes integrated thermal vision system (640x512px TAU 9Hz Flir thermal core and a 720p RGB video camera), as well as an OPTRIS PI450 thermal imaging camera to identify and characterise thermal anomalies.

During the second flight, the thermal channel was transmitted to the ground and displayed in Panoptes' Solar Inspector software. When a hot spot was detected, the drone operator bookmarked the corresponding video frame to analyse later during post-processing.

After data acquisition, post processing began. The 370 still images acquired by the Sony Alpha 7 and the ground control points (GCPs) were processed in Pix4Dmapper Pro in order to create a georeferenced true orthomosaic of the field with 3cm GSD accuracy. Akuo Energy fixed five GCPs at 2cm accuracy over the PV field area and entered them into the Pix4Dmapper software, which helped to improve the absolute accuracy of both the orthomosaic and final reporting.

The orthomosaic was then digitised using a GIS to create georeferenced vector drawings (shapefiles) of the solar panels, to be used as a base map for the final reporting. The georeferenced thermal and RGB-integrated videos were analysed in Solar Inspector software. When playing videos, the operator could switch between the thermal and RGB captures at any time, detecting hotspots and creating text or image annotations in the software. After the video review, the annotation set was ready and could be used to generate the final inspection report.

Reporting

Report generation in Solar Inspector is automatic, with the operator only needing to enter general inspection data. The system used this data, along with the vector solar panel drawings and the annotations, to generate a final file. A Solar Inspector report consists of a coverage map (with the footprints of all acquired video frames), thermal anomaly sheets (one for each detected anomaly) and an index map (with positions of all the anomalies).

Captured thermal data enables hotspots of all sizes to be recognised, whether they be in cells or entire solar arrays. These hotspots are the main indicator of malfunctions and failures in PV panels, and if the user knows the temperature measurement of a hotspot, it can determine criticality levels and prioritise its maintenance planning. The

The thermal channel from the UAV's camera was transmitted to the ground and displayed in Panoptes' Solar Inspector software during inspection

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RGB data provides ancillary information on dirty modules, cracks and so on, and can be used to detect the origin of any possible shadowing on the panels.

Air-Marine also provided a final turnkey report with a map of all the hotspots. Each hotspot had a dedicated file that included position, characterisation, temperature and a final recommendation for Akuo personnel, who could go right to the spot among the 75,000 solar panels and check for potential malfunctioning.

End results

For photovoltaic power plants, the most traditional means of inspection are direct ground inspection and aerial inspection with a helicopter. UAV inspections are dramatically faster than ground inspections and cost less than helicopter inspections. An aerial survey of a 1MW plant, for example, can be performed in approximately 20 minutes of flight. This increased inspection speed can easily be translated into a cost-reduction.

The UAV inspection was carried out in two days, with two operators in the field and one geomatics expert doing post-processing. In comparison to the previous methods of inspecting that Akuo had used, UAV inspection enabled a 50% reduction in time spent on site by field technicians and a 30% reduction in time spent post-processing the IR images.

In the end, having lower inspection costs enable a company to increase the effectiveness and number of yearly inspections, which could be especially relevant in the cases of operation and maintenance contracts linked to plant efficiency.

"UAV inspection in the solar industry is just starting," says Vincent Fournier, chief operations officer for Air-Marine, "but potential customers are more and more aware of solutions for inspecting their facilities."

Both UAV and software technology are advancing quickly, developing more capabilities, such as the ability of Pix4Dmapper to process video natively (Pix4Dmapper 2.0) or upcoming advancements to Panoptes thermal sensors (temperature measurement) and software (feature extraction). These changes will decrease the number of flights needed from two to just one, and create further reductions in time and cost.

Jobard is optimistic about the future. "I would expect that all solar fields will be inspected by UAVs within the next five years."

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