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Maps, databases and time: constructing an information system step by step

The creation of an information system that represents the evolution in time and space of electrical grids is an important undertaking that involves important resources. An alternative to the specification and financing of the system in its entirety right from the beginning is to adopt a system architecture that ingrates elements from different sources and can evolve over time, accommodating needs as they arise. In creating an information system in an incremental manner financial investments can be made over time while immediately benefiting from having the system operational sooner. The article [1] to be presented in the next CIGRÉ session reflects this step by step approach.

To ensure a flexible, expandable system with the capability to accommodate heterogeneous elements asset characteristics must be separated from asset representations. A support tower can be defined by its asset identification number, its relation to the many other assets along the same line, its decomposition of elemental assets, the date in which it entered into service, its life-cycle expectancy and its remaining value. All of which of independent of its respective representation which can include a) geographic coordinates on a map b) blueprint schematic c) three dimensional model of the tower created using LiDAR d) video image surrounding the tower e) ground resistance f) an element in an electrical connections schematic, etc..

These forms of representation coexist simultaneously and vary over time in separate interconnected layers making it important to register the level of precision, the data sources and their errors, validity date and causes of obsolescence, etc. This way, it is possible to maintain multiple representations of each asset – in the form of a map or database – and extract inferences of great value and complexity. When labelec began using the PLMI system in aerial inspections, Labelec did not have access to its clients information systems that describes the grid. As the inspections were performed, the information system was updated with the following entries: geographic location of the lines and their characterisation and localisation of the defects encountered.

Next, vector maps were introduced with geographic location of roads, railways and waterways. It is now possible to use two independent methods to determine the safety distances around the line and compare those with those prescribed by portuguese legislation: signal processing algorithms developed by Albatroz Engenharia and extraction of intersections in the Geographic Information System. The geographic location of towers can also be determined several ways: the project blueprints, the locations estimated by the LiDAR equipment during the aerial inspection and the coordinates taken by ground crews during maintenance inspections and/or interventions. All contribute to represent the tower with differing update frequency and error margins.

As such, the state of each inspected line is continuously updated, archived data is compared with recently acquired data verifying if the defects found have been corrected, the growth rate of the surrounding flora is registered and the evolution of construction and occupation of the surround area is noted. This way a historical record of the lines is created that varies in space throughout its life cycle with similar characteristics to a living organism that must be maintained to be profitable.

Figure 1 - 2D symbolic and vector representation over 2D photo on a GIS (GoogleEarth™).

Figure 2 - 2D point cloud layer over 3D interpolated ground surface

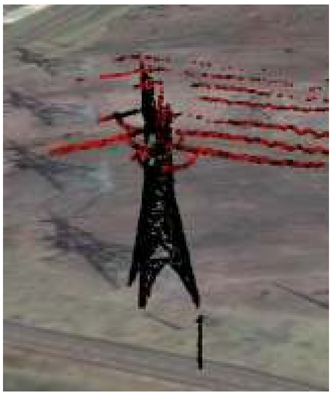

Figure 3 - the same tower with 3D point cloud over 2D surface modelled photo on a GIS (GoogleEarth™).

[1] J. Gomes-Mota[1], Miguel Ramos[1], A. Matos-André[2], “Geographical Information Tools for Overhead Lines Preventive Maintenance”, [1]Albatroz Engenharia SA, [2]Labelec SA, CIGRÉ'08.

Lessons learned after 5000km of line inspections

Lesson #2: hail and fog are worse than rain

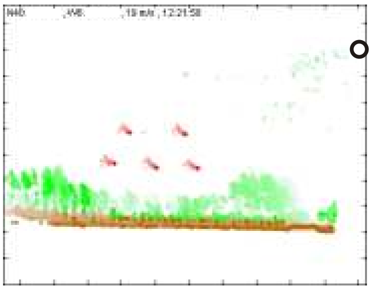

Figure 4 - Hail beginning to fall at 12:21:58.
The helicopter is represented by the black circle: ○
Degradation in the line detection is evident; simultaneously, the helicopter begins to move farther from the line for safety reasons (shown at 70m from the line axis.

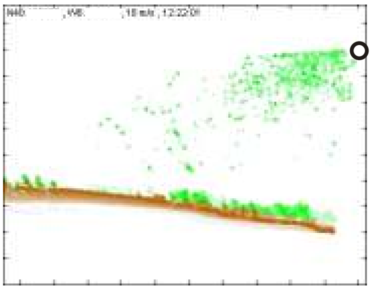

Figure 5 - Three seconds later, the intensity of the falling hail is such that the line becomes undetectable (the green colour indicates “obstacle”).

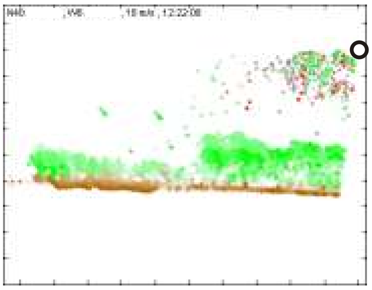

Figure 6 - Five seconds later, the real-time algorithm continues searching for a line and detects conductor candidates in the hail pellets.
Since these candidates do not have geometric consistency, the algorithm abandons these candidates until it successfully detects the line at 12:22:27, when the hail appears to have diminished.

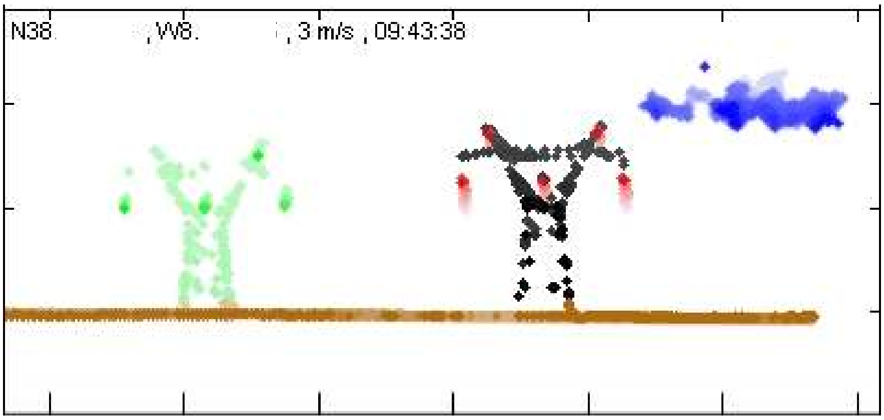

Figure 7 - Image of the classification of the LiDAR measurements. The inspected line is on the right, the conductors in red and the tower in black. The green points correspond to a second line parallel to the inspected line. The blue points correspond to dense fog.

Figure 8 -Synchronized video image with LiDAR data; the second line and tower can be seen the in background.

In Portugal, hail falls sporadically all year round, especially in the spring. The example in Figures 4 and 6 was registered during the inspection of a transmission line completed in April 2007.

On the other hand, dense fog is usually encountered during the Portuguese winter (December to February). Figures 7 and 8 represent LiDAR data collected in December 2007 seconds before being interrupted due to a significant decrease in line detection quality.

Being local phenomena, often after take-off, a patch of dense fog is encountered or hail suddenly begins to fall making the conductors nearly invisible. Rain, tends to cool the conductors, compromising the quality of the thermography inspection but its effects on the LiDAR inspection are negligible.

Under hail, fog and rainy weather, the inspection continues but at a safer altitude until the adverse meteorological conditions have passed so that inspection resources are optimised. However, sensors and human eyes have differing sensibilities to these phenomena and often some see what to others may appear as transparent.

Thus, an integrated system that permits interaction with all types of inspection in real time is essential to alert inspectors to the inspection performance level and provide quantitative data that substantiates the decision of whether or not to continue with the inspection, minimising losses as a result of aborting an inspection unnecessarily and the losses associated with collecting data of inferior quality.

See the fog and hail movies at www.albatroz-eng.com