Vegetation Points-of-Interest (POI) Fused with LiDAR and Aerial Imagery.

Utility Infrastructure Vegetation Management Using LiDAR, Imagery and GIS

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Effectively managing utility infrastructure involves a balancing act of both human and financial resources. It is easy to preach about the concepts of infrastructure preservation, but the hard part is actually doing it. Most agencies are working with legacy budgets that were determined on the back of a paper napkin and were incrementally adjusted for inflation, if they are lucky. These budgets were not the result of a systematic, repeatable or inspection-based approach.

This article will focus on the utilization of LiDAR, imagery and GIS mapping to develop a vegetation management plan that is driven from both the human and financial perspectives. This article will also illustrate the results of a pilot project designed to test this concept and answer the question – "Can a utility take better control of their Vegetation Management costs through the use of LiDAR and Imagery technology"? Can they effectively execute more work with less money through the application of these concepts?

Project Background

Many vegetation programs have followed a strict set of trimming/pruning rules as determined by the utility industry and their supporting forestry contractors. These contractors utilize certified arborists to determine the best treatment cycles/methodologies and then apply these practices across their network on a

GIS Data Can be Used to Plan, Monitor and Track Vegetation Management Activities in the Field

recurring basis. Most of these programs are effectively implemented for their transmission infrastructure, but they are typically a bit behind managing vegetation encroaching on their distribution infrastructure.

Many utilities are working to gather vegetation data from the field in a timely manner so that it is actionable, temporally relevant and most of all, accurate. The data can be collected using a variety of ways – walking surveys, driving surveys, and airborne mapping surveys. For the purposes of this article, we will focus on the airborne mapping survey techniques and the application of this technology to the development of vegetation management work plans. These work plans are designed to provide an agency with:

1. Detailed LiDAR and imagery data collected for their electrical circuits
2. An accurate inventory of Vegetation Points-of-Interest (POIs)
3. A holistic understanding of their vegetation management needs based on a detailed Risk Assessment and Prioritization protocol.
4. A work plan focused on maximizing vegetation removal for minimal cost.

These goals can be achieved through the collection of airborne LiDAR and Imagery which will be processed to a final GIS-based deliverable and packaged within an Asset Management System. This is a cradle-to-grave solution that can be applied to utilities across the U.S.

Gathering the Inventory

The collection of LiDAR data for vegetation analysis can be achieved using a variety of platforms. Each platform is selected to support the task at hand, specifically considering things like scene morphology, line voltage, terrain and accessibility.

For example, transmission lines are typically collected utilizing a fixed-wing or helicopter-based platform. Fixed-wing platforms perform well for flat or undulating terrain and can operate at high altitudes. Helicopters are more versatile in hilly areas and can fly slower for higher density data collection, but in some cases, are not well suited to higher altitudes. In many cases, both of these platforms can perform effectively and provide the client with an outstanding LiDAR product.

Other field conditions present opportunities that are more suited to mobile LiDAR systems. Most distribution lines run through neighborhoods and areas that aren't easily accessible to aircraft, making them ideal for a mobile-based LiDAR solution. Distribution lines are also smaller targets, so a mobile LiDAR solution that provides a higher fidelity data capture process and a higher density product is needed by the utility.

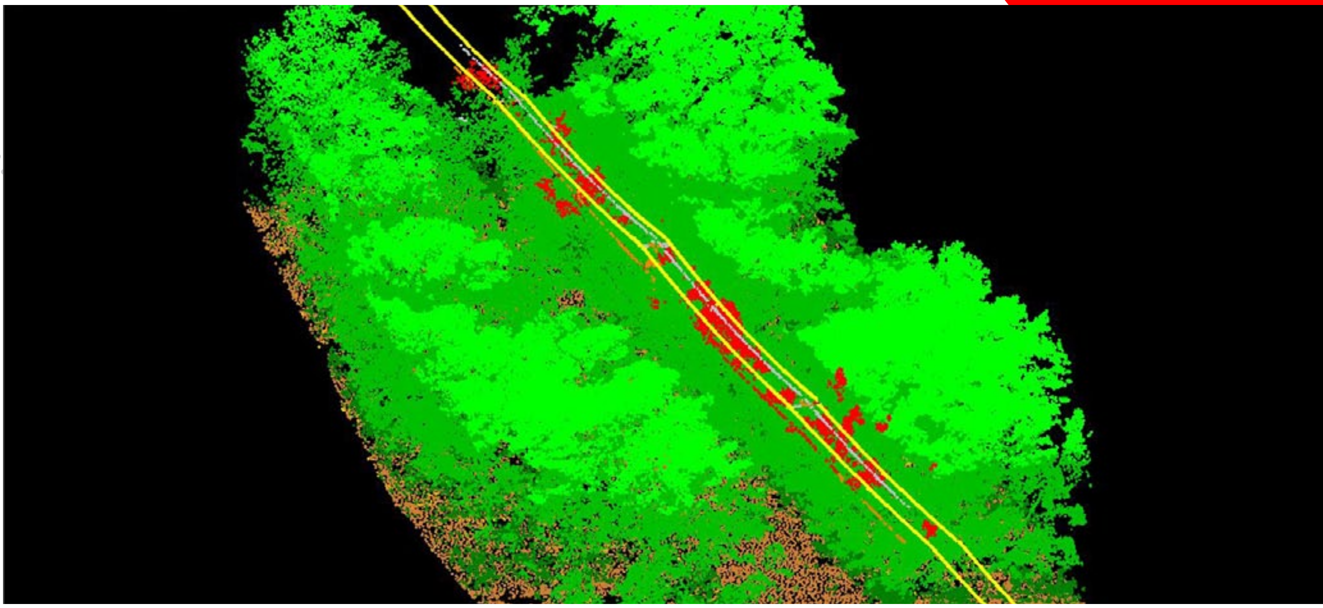
Each of these collection platforms can be configured to provide the required point densities and accuracies required to model vegetation encroachments from LiDAR point clouds. The next section will focus on creating the vegetation encroachment assessment parameters and classifying the LiDAR data to support prioritization of vegetation management activities.

LiDAR Filtering, Editing and Classification

Once we "have data in the can" the work is done, right? Unfortunately, many LiDAR data providers end up "pitching the data over the fence" to their clients at this point and move on to the next project. For us this is actually where the fun part begins!

The next step in the process involves running automated filters against the data to create the ground, building, and vegetation classes within the point cloud. This type of filtering is pretty simple for most seasoned LiDAR providers and can be accomplished with minimal hand-editing. Stringing the conductors and identifying the towers are more of a manual process, but can be created efficiently utilizing the right tools.

Compilers can utilize LiDAR-specific software to hand-classify conductors, insulators, towers and other power infrastructure as needed. Once these points have been classified, the vegetation encroachment analysis can then be run



Classified LiDAR Point Cloud Illustrating Ground (Brown), Vegetation (Green), Conductor (Yellow) and Communication (Grey/Orange) Classes.

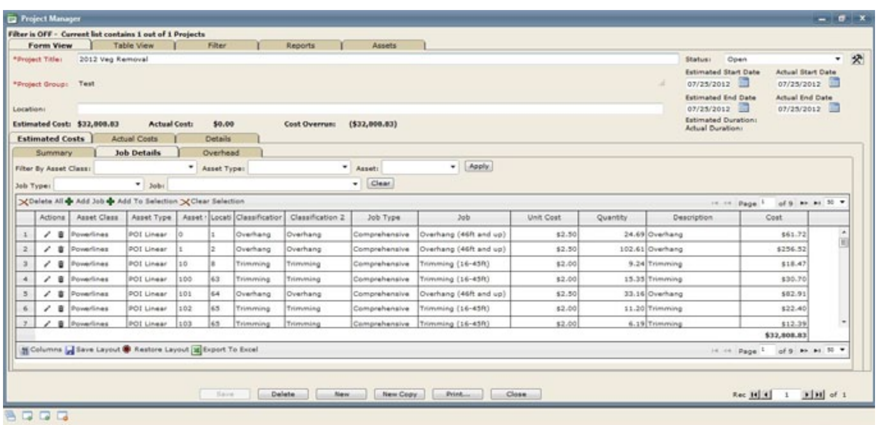
by comparing the conductor points against the localized vegetation points. By classifying the conductors into power and communication classes, it is possible to then analyze vegetation encroachments using a buffer-based approach.

Many of our clients like to use a "blue-sky" approach to search for any vegetation that may be overhanging the conductors, while outside of the buffer zone. The buffer zone is also analyzed using a radial analysis that could be composed of multiple concentric rings of distance. The rings would then be used to classify vegetation encroachments into multiple priority categories based on their risk of causing an outage to the line. Once these encroachments are identified, they will then be managed using a GIS or Asset Management System designed to optimize limited resources while implementing a risk-based approach to vegetation management.

Workplan Development

The final step in this process is to take all of the gathered information and to develop a workplan that is focused on mitigating risk while focusing on high priority areas. This can be done utilizing GIS in combination with Asset Management principles. First, the priority of the asset is determined based on inspection. Then priorities have to be set by analyzing the number of vegetation encroachments along a utility line. Another way to prioritize the work is to combine other factors such as the number of customers served by that line, whether the line is a feeder or not, and based on how many work activities have been performed on that line historically.

Once these priorities have been set, cost factors can be applied to the work activities assigned to that utility line. Specific cost factors related to the type of equipment used (mowing/herbicide, side trimming, and tree-topping) can also be applied to get a better understanding of the funding needed to accomplish this type of workplan.



Accurate Budgets can be Forecasted for Multiple Years for Effective Fiscal Planning and Execution.

Conclusion

In conclusion, it is possible to reverse the trend of "seat of the pants" budgeting by gaining a greater understanding of the actual work that is required in the field to satisfy safety requirements. This is accomplished through inspection, data classification and combining it all to develop a risk-based prioritization approach to utility infrastructure management.

Jason Amadori originally hails from Rochester, NY and began his career as a biologist for the Reedy Creek Improvement District in Orlando, FL. His work with asset management, water quality sampling and NPDES permitting led him to employ the use of GIS and GPS for the creation of maps and databases.