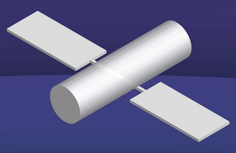
SEEING UTILITY INFRASTRUCTURE FROM DIFFERENT VIEWPOINTS

Satellites' Growing Presence in Aerial Data Capture for Electric Utilities

SATELLITE

PROS

1. Broad field of view with lower data acquisition cost per km^2.
2. Automated, continuous data capture and transfer.
3. Historical data available with hundreds more satellites placed into orbit yearly.
4. No flight limitations, no nuisance to customers, and limited risk to public and assets.



CONS

1. Lower spatial resolution (25 cm^2 commercially available).
2. Must be tasked to capture certain types of data for specific locations in a timely manner (may require more than one satellite).
3. Sensor payload fixed at time of launch (partial offset by dramatic increase in number satellites).

FIXED-WING AIRCRAFT

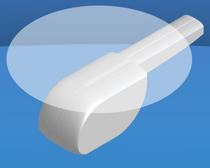
1. Traditionally accepted T&D inspection method.
2. Relatively low-cost data collection per km of linear asset.
3. High spatial resolution over long distances.



1. Multi-angle imagery may require multiple flights.
2. Limited by weather, visual flight rules, and restricted fly zones (same as helicopter).
3. Altitude and flight speed requirements can impact data collection capabilities.

HELICOPTER

1. Close observation with ability to circle asset for different angles of image capture.
2. Ability to use various sensors per mission (common to fixed-wing aircraft and UAS).
3. Typically higher spatial resolution than fixed-wing aircraft.



1. Risk and liability associated with operating close to vertical infrastructure at low altitudes (similar for fixed-wing aircraft).
2. High data collection costs per km.
3. Nuisance to customers near inspection area (less than fixed-wing aircraft).

UNMANNED AERIAL SYSTEMS (UAS)

1. Low cost to deploy.
2. Automated data collection capabilities.
3. Ability to conduct close-proximity inspection with best image resolution.
4. Low risk to personnel and assets.



1. Limited applicability for long range inspection due to FAA regulations and flight time.
2. Lack of standards in the UAS industry.
3. Some payload constraints due to weight and power consumption.

HIGHER PRIORITY T&D USE CASES FOR SATELLITE DATA ANALYTICS

TRANSMISSION AND DISTRIBUTION LINES INSPECTION

All of the platforms and supporting sensor technologies can aid in the inspection of T&D lines and other assets. Fixed-wing aircraft and helicopters are proven platforms with an established operational history. UAS is an emerging platform that is growing in applicability to conduct very detailed, localized inspections. Asset health assessment, right-of-way encroachment, and physical security are possible applications to consider.

MONITORING VEGETATION GROWTH TO INFORM MANAGEMENT TASKS

Wide-area assessment of trees and ground cover on or near the rights-of-ways can be analyzed periodically using satellite data to drive precision utility work or inspections by fixed-wing aircraft/helicopters/UAS of areas flagged by the first-pass assessment using satellite images. Tree height, crown characteristics, health, growth rate, and encroachment can be assessed by fixed-wing aircraft and satellite.

RIGHT-OF-WAY CHANGE DETECTION

Change on the utility right-of-way (ROW), either by unauthorized activity or by erosion and change of the landscape, is usually detected during a routine inspection. Land movement can be gradual and may go unnoticed by manual inspections and be missed by flyover inspections. Advanced analytics using data from multiple satellite inspections of an area can help identify areas of change over time and alert utility staff of potential damage or encroachment. Frequency and resolution of data capture are key to determine how best to use satellites and other airborne technologies.

AERIAL SYSTEMS TO GUIDE DAMAGE RESTORATION

Utility assessment of and response to a large-scale storm event must be quick and efficient. Satellite imagery and analytics can assist during and in the minutes following a storm to provide a high-level assessment. Once the storm passes, fixed-wing aircraft and helicopters can be used to provide a more detailed analysis as the restoration effort continues. Local line-of-sight assessments can be conducted by UAS. It is important that utilities consider how best to layer the technologies together for an efficient restoration effort.

For more information and sources, see *Eyes in the Sky: Satellite Remote Sensing and Data Analytics for Electric Utilities*, an EPRI Technology Insights Brief available at www.epri.com

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