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Automated Drive-By Distribution Asset Inspection

noteworthyai

Startup
Noteworthy AI
Stamford, CT

Host
FirstEnergy

FirstEnergy

Technology Solution

The increasing severity and frequency of extreme weather and wildfires threaten the reliability, resilience, and safety of the electric grid. Proactive inspection of the inventory of distribution lines can help guide maintenance and safety upgrades to mitigate risk from extreme events. However, currently available inspection methods—from the ground, a bucket truck, or by unmanned or manned overflight—are costly and time consuming and require active worker involvement.

This pilot project tested Noteworthy AI's automated system for distribution asset inspection using machine vision, edge computing, and AI technology deployed on existing utility fleet vehicles. The Inspector Edge pairs a rooftop-mounted high-performance camera with an in-vehicle computer with machine vision software, allowing assets to be surveyed during normal driving. Poles are automatically geolocated, pole-top components are identified, and problems and defects can be diagnosed, drawing on the remote Inspector Cloud. This innovation transforms travel between work sites into an opportunity for passive inspection via collection of real-time data. Benefits include a higher level of asset monitoring and risk mitigation at reduced cost compared to existing processes.

The Inspector Edge's exterior unit features rooftop-mounted cameras for capturing images of roadside distribution infrastructure.

Project Overview

The objective of this pilot project, hosted by FirstEnergy, was to test Noteworthy AI's data capture solution and its ability to collect and analyze high-quality imagery of distribution assets for use across a variety of field inspection functions including GIS cleanup, equipment inventory, and defect detection. The demonstration project scope included the following: install the Inspector Edge system on two FirstEnergy bucket trucks, capture at least 80 hours of field-collected imagery, filter and label the imagery to support AI model development, and assess technology value.

The camera portion of the Inspector Edge system, designed for deployment on diverse vehicle types, was installed on the roof of each bucket truck's cab using a suction-cup attachment, and the computer was deployed behind the passenger seat and plugged into the vehicle's electrical system outlet. Images were captured by driving along pre-defined distribution segments—an urban/suburban setting and a rural setting—and then labeled and used to develop and train an AI model for inventorying pole assets and recognizing problems.

The trained model was deployed to the fielded Inspector Edge units, and a field test commenced: One of the FirstEnergy bucket trucks was driven along a route with 86 existing distribution poles, according to GIS information provided by the utility.

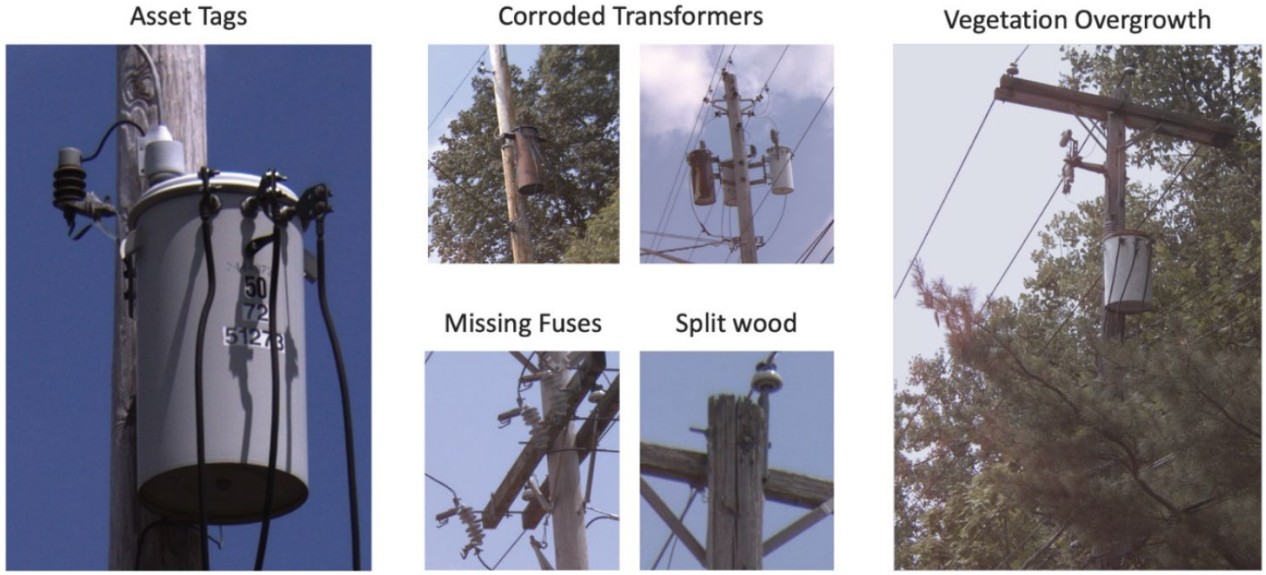
The Inspector solution is active when a vehicle is in motion. The computer vision models, which run entirely on the computer deployed within the vehicle, employ object detection to perform the following tasks:

- **Pole detection and geolocation:** identifies distribution poles and provides the approximate geographic coordinates.
- **Component detection:** identifies pole-top components such as transformers, insulators, cutouts, lightning arrestors, crossarms, etc.
- **Defect detection:** identifies corroded transformers, broken lightning arrestors, damaged crossarms, etc.

Results & Learnings

Approximately 5000 images of distribution poles were captured during drive-by testing of the Inspector solution, and its capability for identifying assets and assessing field conditions was demonstrated. Raw images illustrating examples of corroded transformers, missing fuses, cracked poles, vegetation overgrowth, and asset tags are shown in the photo.

The key challenge encountered in this pilot test involved basic photography 101: getting the shutter speed needed for a vehicle moving at different speeds, getting the aperture opening correct under dynamic lighting conditions, getting the camera angle right while passing by infrastructure, etc. After substantial work by the project team, the Inspector Edge system obtained imagery sufficiently detailed to enable reading of ID numbers on distribution poles.



Digital images automatically captured by the Inspector Edge are suitable for identifying individual assets and for highlighting a variety of potential problems.

In terms of asset identification, Noteworthy AI's solution was able to detect poles ~80% of the time, with an average GPS precision of ~20 ft, over three passes of the vehicle along the drive-by testing route. The success rate was a function of vehicle speed, pole location relative to the road, and other environmental conditions. Additionally, the technology proved capable of accurately identifying pole-top components using the trained object detection model. During this short-duration project, the model's mean average precision improved from 81% to 90% at an intersection over union of 0.5.

Field tests of new and innovative technology often encounter unexpected obstacles, and this distribution inspection automation project was no exception. Key lessons learned relate to attaching and operating the Inspector Edge hardware. The suction-cup mounting approach was improvised because the planned magnetic solution was unsuitable for the aluminum roofs on FirstEnergy's bucket trucks. Also, a battery-powered uninterruptible power supply was added during the pilot to protect the on-board computer from voltage drops experienced during vehicle startup. Production versions will need to include a more permanent mounting solution capable of withstanding frequent tree branch encounters. Additional refinements may be needed to avoid interference with bucket arms and vehicle antennas and to protect the on-board computer.

Implications & Next Steps

Overall, this project demonstrated the feasibility of terrestrial-based distribution asset imaging and data capture from passing utility vehicles.

Building on successful demonstration of AI-based asset identification, next steps will focus on training and testing algorithms for automated detection and proactive mitigation of pole-top problems.

Despite challenges related to vehicle integration and variable lighting conditions, the Inspector system was able geolocate poles, capture imagery, and inventory assets with a high degree of accuracy and precision.

FirstEnergy and Noteworthy AI plan to continue with an expanded pilot in 2022 focused on assessment of Inspector's defect detection capabilities alongside its potential for reducing operations and maintenance costs and improving resiliency to extreme weather. Additionally, Noteworthy AI will apply many of the learnings uncovered during this project to further develop its solution. This includes upgrading the Inspector Edge unit to more easily integrate with vehicle electrical systems, as well as providing more options for mounting the camera unit.

TESTIMONIAL: Noteworthy AI

This pilot provided an opportunity to not only prove Inspector's capabilities with a major utility but also to afford our team with invaluable learnings for advancing our technology. All of the hard work by both FirstEnergy and EPRI during this project is greatly appreciated, and we're excited to continue the relationship.

TESTIMONIAL: FirstEnergy

Building on the overwhelming success of this Incubatenergy Labs pilot, FirstEnergy plans on expanding the project to help develop other use cases for vehicle-mounted imaging and to gain an understanding of the potential for real savings on an enterprise level.

TESTIMONIAL: EPRI

Noteworthy AI's innovative approach demonstrated viability as a utility vehicle retrofit solution for distribution inspection that couples their AI-based analytics with commercial off-the-shelf technologies. Images collected in this pilot also augment our growing AI.EPRI library, and we encourage utilities to share data in support of diverse AI-assisted innovations.

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