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Machine Learning Enables Utilities to Create Digital Assistants that Retain Institutional Knowledge, Troubleshoot Problems and Improve System Reliability

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SUMMARY

At many electric utilities, the go-to resident operations & maintenance expert is a seasoned field technician who has, over decades, seen and done it all. When this bastion of institutional knowledge retires, many of these same utilities often find themselves at a loss. The replacement – if there is one – often has less experience and is insufficiently equipped to address the most challenging field issues, much less any new, never-before-faced issues that may arise.

Such problems are widespread – and increasingly urgent. The U.S. Department of Energy estimates that a quarter of U.S. electric and natural gas utility workers will be ready to retire within five years.

One solution to the looming tsunami of retirements and the loss of institutional knowledge may be closer than these utilities may think. Thanks to machine learning, it may rest in the development of smart digital assistants embedded with artificial intelligence.

The same machine-learning algorithms that make Amazon's Alexa or Apple's Siri possible also have the potential to help future utility workers do their jobs more safely and effectively.

Imbued with decades of training data and utility experience, these digital assistants will be able to understand and communicate with field workers, predict failures and troubleshoot performance issues.

The phone in a technician's pocket, in fact, may one day be their most important tools, helping them to respond rapidly to common problems and troubleshoot ambiguous new ones. The time will come when workers will not know – or care – if they are interacting with a computer. Similarly, the artificial intelligence-enabled devices will allow technicians in the field to respond quickly and accurately to vexing and ambiguous problems without customers ever knowing they existed.

KEYWORDS
Digital assistant; machine learning; utility O&M; machine vision; acoustic analysis; voice synthesis; pattern recognition technologies

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Consumers that rely on Apple's Siri or Amazon's Alexa for information and support have witnessed the dramatic improvement these digital assistants have experienced in the relatively short time since their introduction.

Sophisticated machine-learning algorithms have improved digital assistants' ability to analyze a user's information needs and correctly identify the data and response that addresses them. These algorithms, in combination with rapidly emerging voice synthesis and pattern recognition technologies, are now not only capable of interpreting a diverse range of speech patterns and dialects, but also associating and matching key words and phrases with the information a user is seeking.

Today's digital assistants, in other words, provide an increasingly human-like experience, helping consumers in wide-ranging simple and complex ways, from translating foreign languages to remembering where they parked their cars.

The same technologies have the potential to help future utility workers do their jobs more safely and effectively. The phones in utility workers' or field technicians' pockets, in fact, may one day be their most important tools, helping them respond rapidly to common problems and troubleshoot ambiguous new ones. Imbued with decades of training data and utility experience, these technologies could eventually augment and support technical O&M support staff, growing so sophisticated that field staff are unable to distinguish between them and seasoned human professionals.

The case of the failed transformer

Consider, for example, a future scenario where a line technician goes into the field to inspect a malfunctioning transformer on a utility pole. Based on fluctuations in the power quality, the technician suspects failure is imminent and calls into the office. The digital assistant on the other end of the line "listens" to and analyzes the technician's observations, identifies the problem and then provides directions for possible solutions. Even if the technician's language is imprecise or spoken in a local dialect, the digital assistant is able to understand and fill in any blanks for words that may fail the worker.

Voice recognition is just one of several rapidly advancing technologies that make seamless, expert, non-human interactions a real possibility in the not-too-distant future. Others include:

Machine Vision – Camera phone pictures and image recognition software are taking face recognition technology to places once thought possible only on the pages of science fiction. For example, this technology can already identify people in a photo when it is uploaded to a social media platform and compared with the database of existing users and their pictures. These same technologies could be applied to recognize patterns unique to the utility industry.

Consider again the future scenario where the line worker encounters a transformer problem in the field. A close-up photo of the affected equipment could be uploaded to a central server. The massive computing and associative power of image recognition technology could find patterns in the image that the human eye may not be able to recognize, or that humans even know exist.

Back in the field, a line worker can listen as a digital assistant on the other end of the line discusses potential issues it recognizes. Discoloration around the edges of a transformer cannister, for example, may be recognized as a potential site of oil contamination. The size, color and consistency of the discoloration may further help predict the nature of the contamination and the likely time of failure. The digital assistant could then check the inventory system to see if a replacement is available.

Beyond helping the line worker, each photograph and its associated data help the system grow more advanced and capable of recognizing problems and solutions. This AI-enhanced technology, for example, could use the images to learn other information that will aid future unrelated inquiries.

The deteriorated condition of metal line cables and connections, for example, may suggest a supplier had shipped substandard parts. Stress and strain marks could potentially be used to predict time of failure and to audit manufacturer quality, information that can be used to support future purchasing decisions. Similarly, corrosion on cables may suggest the presence of unanticipated airborne contaminants from a nearby industrial facility, driving a decision to require additional protective coatings on future installations.

Acoustic Analysis – The sound recognition technologies that enable Siri and Alexa to understand questions and comments from line technicians can also be used to "listen" to equipment itself and support digital assistants' efforts to provide insights into and solutions for equipment issues. In this example, the technician could stream the sounds emanating from the transformer cannister to a central server. While the technician might just hear the expected low-level hum associated with a properly performing transformer, the digital assistant could potentially pick out very subtle fluctuations in the hum's pitch. Based on past sound captures, it could associate the sound from the transformer with that of other past failures and make predictions on what is happening at the site.

Similarly, a digital assistant could learn to hear the tones of transmission wires as they sway back and forth. Creaking noises could be analyzed and compared to the sounds emitted by lines right before mechanical failure and snapping. In addition to serving as helpful training, these sounds could be used to identify preventative measures that will help maintain system reliability.

As with the ability of machine vision algorithms to isolate and identify patterns in cell phone photos, the very high and low pitches that computers can detect and analyze are likely beyond what the human ear is capable of perceiving. The digital assistant on the other end of a phone line could go far beyond its human counterpart who, despite decades on the job, does not have the hearing astuteness to distinguish line sound from the bird and wind noise that muffle it.

Meta-Data -- The true power of the machine learning age is in the ability to combine and analyze vast amounts of data with speed and efficiency. The insights drawn from connecting disparate data sets can be used to make ever more accurate predictions and spot patterns previously hidden due to the limited analytic abilities of humans. A digital assistant on the other end of a phone line would not have these limitations.

In the example described previously, the digital assistant could match the images and sounds it receives with local weather, seismic and wildlife information, mining the results to see if these factors could be contributing to transformer fluctuations and potential failure.

Local temperature, precipitation and wind data, for example, could be helpful in analyzing the stresses on equipment. Wildlife data could predict if termites or other invasive species are likely to eat away at a wooden pole structure. Air quality reports could be used to predict unusually high concentrations of salt in the air or industrial contaminants that could contribute to early corrosion. Seismic data could be used to predict ground unsettling and future pole collapses.

The combination of any one of these data sets could help utilities predict future failures. Even more importantly, the ability to combine and analyze all of these data sets would create even more powerful predictive capabilities.

The knowledge gleaned over the course of a few years would far surpass that gleaned from humans spending decades in the field identifying one problem at a time. Machine learning's ability to take in vast amounts of past and present information could provide the edge utilities need to bring power to their customers reliably and efficiently.

Taking the first step into the future

In the not-too-distant future, a line technician will be able to make a phone call, and the digital voice on the other end of the line will be virtually indistinguishable from the human voices of today. In the

future, however, the “brain” behind this voice will have the ability to spot minute details and patterns that even top experts would be unable to detect after years in the field.

While the technician might speak in slang, jargon or stumble over words, the digital assistant will seamlessly understand what the caller is trying to say. It will be able to improvise and predict what the technician is “getting at.” If a human expert with decades of experience cannot be replaced after retirement, in other words, the digital assistant will be fully prepared to take up the mantle and develop further insights without skipping a beat. Out in the field, the technician is none the wiser.

But this future won’t be realized without help. Utilities would be wise to invest in digital assistant technologies and begin building databases of images and sounds that can be linked with geographic and weather data.

A pilot project using an off-the-shelf voice assistant program to gather data is a great place to start. Third-party consultants can help refine the voice interface and machine algorithms, if needed. The digital assistant will also need to be trained on the speech patterns of average field workers, including the lingo and nuances associated with the data they will likely seek.
The sooner utilities can train digital assistants to recognize hazards and understand the line technicians they are interacting with, the better able they will be to tackle the most difficult emerging challenges.

The time is coming when line workers will not know – or care – if they are interacting with a human or a computer when they encounter a problem in the field. Thanks to the machine learning and artificial intelligence that make it possible to predict failures and troubleshoot performance issues, utility customers will likewise never know – or care – that a potential problem even existed.

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