Managing overhead transmission assets—including towers, conductors, insulators, and other components, as well as the right-of-way itself—is a costly and sometimes dangerous proposition. Many lines are located in remote, rugged environments. Frequently, inspection workers conduct helicopter surveys or must climb towers. Some equipment cannot be inspected due to hazardous conditions or access restrictions. Robotic inspection systems being developed by EPRI's Office of Technology Innovation promise to reduce costs, enhance safety, and expand coverage while improving reliability.

What is robotic inspection?
Robotic inspection involves the use of autonomous or remotely controlled machines that incorporate imaging, sensing, and other technologies to assess the condition and status of transmission system components. The idea is to reduce or eliminate human exposure to potentially dangerous environments while collecting the data required for meeting stringent reliability standards on tight maintenance budgets.

What is EPRI’s role?
EPRI has years of experience in condition assessment, sensing, and maintenance, and is exploring three innovative robotic technologies: a transmission line inspection system for traversing conductor shield wires, a specialized device for climbing and evaluating insulators, and snake-like robots for reaching otherwise inaccessible locations. All will integrate advanced mobility, energy management, sensing, analysis, and communications capabilities—many being developed by EPRI—to gather comprehensive and accurate data for optimizing maintenance and enabling just-in-time intervention.

How does the robotic transmission line inspection system work?
The autonomous transmission line inspection robot is intended to reduce or eliminate the need for helicopter overflights while supporting a transition from scheduled to condition-based maintenance on both existing and new corridors. The robot is designed to crawl over conductor shield wires along an 80-mile-long corridor a minimum of twice per year. Its motors will run on power harvested from shield wires, supplemented by output from on-board solar panels. High-definition cameras and other equipment will identify nearby trees that could pose a risk to wires, evaluate right-of-way encroachment, and assess component condition by comparing images taken from different locations and at different times. Simple electromagnetic interference detectors will identify discharge activity and other indicators of faulty equipment.

Robotic inspection systems for transmission systems will integrate advanced sensing, processing, communications, mobility, and power harvesting technologies to deliver actionable data for just-in-time maintenance.

The robot also will be equipped to collect data as it passes remote instrumentation deployed along a transmission corridor, such as EPRI-developed radio-frequency sensors situated on towers and lines for detecting lightning strikes, wind-related damage, and corrosive conditions. Data processing, global positioning, and two-way communications systems will analyze and deliver time- and location-stamped data and images to maintenance personnel. High-risk issues and potential problems that require further investigation or immediate action will be flagged, and information on the robot’s status and speed will be provided.
What is the technology’s status?
A prototype of the transmission line inspection robot is undergoing evaluation at EPRI’s testing facilities. Measuring 6 feet long, the device incorporates a top shell of solar panels and a set of underside rollers for traveling along the shield wire. A diverter mechanism enables the robot to navigate over splices, marker balls, and pylons. The rollers also provide the capability to dock at towers, allowing the robot to short out insulators and harvest power from the shield wire due to its proximity to high-voltage lines.

Ongoing developmental work focuses on mobility and energy management issues, as well as on integration and testing of advanced imaging, sensing, data processing, and communications capabilities. Construction of a next-generation prototype is scheduled for 2011, followed by laboratory and field testing campaigns. Initial commercial demonstration of the transmission line inspection robot may take place on a 275-mile-long corridor being built in Columbus, Ohio.

For insulator inspection, a detailed mechanical model of a specialized robot has been completed, fabricated, and successfully demonstrated at EPRI’s facilities. The potential of snake robots—which in other applications have proven capable of climbing vertical surfaces, adapting to changing circumstances, and delivering sensing elements to dimensionally restrictive and hazardous areas—also is being investigated.

What are potential benefits from robotic transmission line inspection?
An aging asset base, stringent vegetation management and reliability requirements, and continuing budget pressures increase the need for thorough, timely, and cost-effective monitoring and condition-based maintenance along the entire length of transmission lines. Robotic inspection promises to deliver actionable condition assessment data and information from environments that cannot be readily accessed today, as well as to improve worker safety. EPRI’s transmission line robot—in combination with a new generation of low-cost radio-frequency sensors—is expected to significantly improve inspection and monitoring capabilities relative to hovering helicopters, with the potential for savings of 30% or more.

For more information
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