Ground Based Robots & the Future of Applications of Robots for Transmission Line Work

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Abstract

The increase in competitiveness of robot technology has resulted in a dramatic growth in both the number and way in which robots are used in applications. The use of robot technologies for utilities is relatively new, but is becoming more and more valuable; especially in energy markets where outages and congestion translate into costs for both generators and load.

In this paper, we explore the following topics related to robots and their use and value as a tool to transmission utilities.

- Current Types of Robots Available in the Industry
- Past Experience with Ground Based Robots
- Basics of Robots Suspended from line
- Basics of Unmanned Aerial Vehicles
- Methodology to Estimate Benefits of Energized Work

We will conclude with a look into what the future of transmission line robotics might hold.

Current Types of Robots Available in the Industry

There are at least five different types of robots that are currently being employed in the utility industry. These robots include ground base robots, robots suspended from lines, aerial based robots, climbing robots and insulator robots.

Ground based robots have been used as a proven technology for utilities for more than 10 to 15 years. In most utility uses, ground based robots have been designed to remotely capture and control energized conductors and operate in contact with the ground. Ground based robots have the ability to perform heavy duty, maintenance and construction tasks, beyond human capability. Additionally, they can act as a temporary transmission line structure and perform other duties.

Robots suspended from the line are designed to serve as an extended eye and arm of transmission lineman. Robots suspended from lines have been used in utility practice for approximately 5 to 8 years, but have proven to be effective as a mobile platform to perform visual inspections and light duty maintenance tasks.

Aerial based robots are designed as a mobile platform to perform visual inspections of electric facilities. While aerial based robots have predominantly been used outside of North America, they have been employed by utilities for more than 5 years to serve as an extended eye of transmission linemen.

Two other robots that are less popular, but have been used in utility practice include climbing robots and insulator robots.

Past Experience with Ground Based Robots

Ground based robots in the electric utility industry are designed to remotely handle, move, and relocate energized conductors of different voltages. The Line Master technology, in particular, was specifically designed to address heavy duty tasks including live line procedures such as the replacement of rotten poles utilizing their existing hole, reframing and reinsulating structures (which are typically difficult to execute with traditional live line tools like hotsticks), or controlling the insulated arm through hydraulic power from a remote hydraulic power source.


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Ground based robot applications for electric utilities include:

- Structure repair, replacement and temporary support
- Replacement of insulators
- Reconductoring of lines
- Replacing line spacers
- Adding circuits to structures
- Selective substation repairs at energized base load generation plants, including nuclear plants
- Other miscellaneous maintenance tasks

Basics of Robots Suspended from line

Robots suspended from transmission lines are designed to move over live or ground transmission line conductors and overcome “obstacles” such as suspension clamps/insulators. Their specific applications include detailed inspection of transmission line components (including cables and dampers), corrosion detection and insulation cleaning. Robots suspended from transmission lines are generally controlled by a ground operator and have been used for both research and commercial application in Canada, Japan, USA, Brazil and China.

Basics of Unmanned Aerial Vehicles

Unmanned aerial vehicles are probably the fastest growing robotic technology. Potential applications for unmanned aerial vehicles include replacing human tower climbing inspections (while getting comparable results), assessing transmission infrastructure after major natural events, and assessing transmission line construction progress. While the technology and potential application of unmanned aerial vehicles has greatly improved in recent years, there are some barriers to entry that are holding its use back, including the Federal Aviation Administration and Transport Canada.


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Methodology to Estimate Benefits of Energized Work

When exploring the use of robots for performing energized transmission maintenance, it is important to quantify the economic benefits to support your business case. Several metrics that utilities should look at to capture the economic benefits include:

- Redispatch/Production Cost
    - Usually represents the potential savings.
- Transmission Service Reservations
- Savings in Man Power
    - Often Negative due to increase in time to perform maintenance

Additionally, there is a “value at risk” component that is tied to utility reliability metrics and potential penalties associated with low reliability performance.

Conclusions and Future of Transmission Line Robotics

In conclusion, adoption of the use and application of robots for transmission line work is increasing. However, we must understand that each robotic technology has specific applications, advantages and limitations. At the end of the day, the future of robots lies in a sound business case that is based on value to the end user. This includes cost, safety, function and performance.