

# Intelligent Control of Energy Distribution Networks

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**Abstract** There has been continuous research in the energy distribution sector over the last years because of its significant impact in modern societies. Nonetheless, the use of high voltage power lines transport involves some risks that may be avoided with periodic reviews. The objective of this work is to reduce the number of these periodic reviews so that the maintenance cost of power lines is also reduced. This work is focused on the periodic review of transmission towers (TT) to avoid important risks, such as step and touch potentials, for humans. To reduce the number of TT to be reviewed, an organization-based agent system is proposed in conjunction with different artificial intelligence methods and algorithms. This system is able to propose a sample of TT from a selected set to be reviewed and to ensure that the whole set will have similar values without needing to review all the TT. As a result, the system provides a web application to manage all the review processes and all the TT of Spain, allowing the review companies to use the application either when they initiate a new review process for a whole line or area of TT, or when they want to place an entirely new set of TT, in which case the system would recommend the best place and the best type of structure to use.

**Keywords** Power lines management · Intelligent systems · Agents · Virtual organization · Data analysis · Case based reasoning · Artificial neural networks

## 1 Introduction

Power line maintenance is a problem that has generated a variety of research lines [9][4][3]. The transmission towers (TT) that support the power lines must be

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reviewed on a regular basis depending on their characteristics. In these reviews it is necessary to determine the ground resistance, as well as the step and touch potentials. These reviews involve a significantly high cost. However many of the reviews could be predicted, as most of the TT share the same features and are located on similar terrain. Therefore, the possibility of reducing the costs associated to this kind of maintenance is not only attractive, but quite reasonable.

As technology has continued to advance, there have been different approaches that attempt to apply innovations both in the review and the maintenance processes, resulting in a common need to reduce costs. Indeed, this is precisely the reason for having created the proposed predictive maintenance system.

There are 4 common maintenance types for TT: i) corrective, to solve existing problems; ii) preventive, to prevent the system from failures; iii) predictive, to predict possible irregularities; iv) proactive, which is a combination of preventive and predictive maintenances. The present work is focused on the predictive maintenance, where different techniques are already being used. Some authors have used artificial neural networks to model the environment, including [11], while other authors use neural networks to set failure times of the devices [13]. In addition, data mining or machine learning techniques are used to model different systems.

This study proposes a virtual organization of software agents capable of carrying out a predictive maintenance of TT by selecting only a sample for review. This selection is completely autonomous and is based on different TT parameters that make it possible to determine the status of the analyzed lines of the TT. The system has built-in statistical sampling techniques combined with neural networks to estimate the ground resistance, as well as the step and touch potentials. In addition, the system provides different geopositioning tools to facilitate the search and selection of the TT and lines to be sampled.

The paper is organized as follows: section 2 includes a revision of related work, Section 3 describes our proposal, and finally section 4 provides the preliminary results and conclusions obtained.

## 2 Proposed System

As mentioned before, there are different kinds of maintenance types [1]: corrective, preventive, predictive and proactive.

Predictive maintenance refers to the capacity of generating assumptions or estimations about the status of a component. When predicting well-known processes, especially in Control Theory [10], it is possible to generate a mathematical model which represents reality in a reliable way [8]. However, in other processes experimental techniques are needed, for example classification algorithms [7] or artificial neural networks [11]. This approach tries to extract and model the system features from historical data.

Support vector machines are used in [14] to predict the amount of ice that will be accumulated in aerial power lines. This is a serious problem that can interrupt the electrical service for a significant time, and the solution could be really expensive. Because of that proposed work, it is possible to estimate the level of ice (with a