A Hybrid Bayesian Network Based Method to Assess and Predict Electrical Power Network Reliability

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***Abstract*— Along with the development of the supervisory control and data acquisition system, electrical power network breakdown maintenance and support become more difficult. Several models were developed to solve the problems in electrical power networks reliability. The paper adopts a hybrid Bayesian network model, defines the failure rate of different fault of switches, models the switches which have a dynamic behavior by Dynamic Bayesian Network (DBN), and give some flexibility in the framework of data analysis. The research is valuable for predicting the behavior of the electrical power network automatically and improving the availability of the power and the decision making environment.**

Keywords— Hybrid Bayesian network, Electrical power, Reliability, Availability

I. INTRODUCTION

Electricity, the most widely used source of energy, has become familiar through its use in domestic or industrial settings. The transmission and distribution of electrical power is by cable, but a system of transport or distribution of electricity requires other equipment and appliances. Every electrical power supplier around the world must satisfy the demand on electricity; something which is tending to increase. The regulations and the clauses of the supply contracts require that the supply of electricity must be done while ensuring the quality and continuity of service. However, several technological solutions exist to improve the quality of electrical power such as active power filters and this for conventional and renewable energy sources [1].

For service continuity, the scientific community has also sought to provide technological solutions for localization and detection of faults on electrical networks [2]. In practical terms, power system operators use control and data acquisition systems such as the SCADA system. Using various protocols, control and data acquisition systems can interrogating field devices via some functions, allowing precisely locate any breakdown, power cut, voltage drop, aggression, and support of the electrical network operation.

The desired final objective by the operators is to improve the reliability of the electrical power networks. Electricity demand and consumption forecasting is one way to improve the reliability of power networks [3]. Several artificial intelligence methods have been used to solve these problems, for example: artificial neural networks, support vector machines, fuzzy logic and least squares support vector machines. Another contribution shows that costs can be the basis of an otpimisation model of the reliability function of a distribution system [4]. These costs are mainly: the value of switching devices, the direct and indirect costs of maintenance, and finaly the investment. An approach was presented by [5] in the objectif to modify the failure rate of a distributor segment and the repair time. It's based on calculating the outage due to overloading and omission of the repair time.

In the same context and in an aim to have future information for predicting the behavior of electrical networks, probabilistic graphical model will be developed. This is the contribution of this paper. Through a hybrid Bayesian model, the reliability of the electrical power network will be modeled. The static and dynamic elements of the network will be modeled in the same model. The developed Bayesian network is an association of a static Bayesian network and a dynamic Bayesian network.

II. HYBRID BAYESIAN NETWORK

Bayesian network models present powerful modeling tools for resolve some problematic regarding reasoning and decision making under uncertainty. These Bayesian networks offer flexibility and a wide range of applications. They can be used for diagnosis, prediction and safety [6,7,8]. The calculation of conditional probabilities is the basis of Bayesian networks. They bring together the theory of graphs and that of probabilities [9].

A. Bayesian network in general

A Bayesian network is an acyclic oriented graph. They are also called probabilistic networks, causal networks or belief networks. Bayes' theorem given by the formula (1) calculates the probabilities of the events whose relationship is of the cause - effect type.

Given two events A and B, conditionally related:

$$p\left(\frac{A}{B}\right) = \frac{p\left(\frac{B}{A}\right)p(A)}{p\left(\frac{B}{A}\right)p(A)+p\left(\frac{B}{\bar{A}}\right)p(\bar{A})} \qquad (1)$$

In the Bayesian formalism, nodes represent random variables and directed edges imply local conditional dependencies between theses nodes. Multivariate probability distributions are modeled and represented by a probabilistic

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