Comparison of Bayesian and Fuzzy ARTmap Networks in HV Transmission Lines Fault Diagnosis

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Abstract: - Fault diagnosis is a vital discussion in power systems restoration. Recently, much research endeavors have been done for fault section diagnosis of power systems by using several techniques, such as rule-based expert system, logic-based expert system, fuzzy relation based expert system, neural network, optimization techniques based approach, etc. They diagnose the fault from different ways. However, each approach has its limitations. In this paper, a Bayesian approach by RBF learning using a simulation technique, the Markov chain Monte Carlo (MCMC) and Fuzzy ARTmap network are proposed to predict the fault in a typical power transmission line and the results are compared.

Key-Words: - Bayesian Network, Fuzzy ARTmap, Transmission Line, Fault Diagnosis, MCMC, Variable Thevenin

1 Introduction

HV Transmission lines are one of the most essential equipments in the electrical power systems. While a short circuit in a power system is occurred, protective relays will operate and clear the fault. Keeping in mind that in larger power systems, multi circuits' transmission lines, more relays, registers, circuit breakers, etc are exist. So, number of warnings dispatched to control center during the fault accruing is much more. In case those main protections do not operate properly and on-time, back up protections will operate related to this situation. There are two main negative consequences: first, it causes undesirable load interruptions of other buses, and second, leads to decision making of operator in emergency conditions to be more difficult, according to variety of dispatched warnings to main control center.

Due to it involving a lot of uncertain signals, which are caused by many factors, such as mal-operation and non-operation of circuit breakers or relays, data-transmission error of loss, the inaccurate time of the protective operation, fault diagnosis of network needs uncertainty reasoning. Among the existing uncertainty reasoning approaches, Bayesian networks approach stands out as the only one that is directly grounded in probability theory. Bayesian network based approach, mainly used for representing and reasoning with uncertainty, has been successfully used in many fields, such as speech recognition, industrial control, economic forecasting, as well as medical diagnosis [1]. Recently, with the development of Data Mining, the capabilities of inference and learning of Bayesian network have gained more and more attention. However, little researches have been done to address how to use Bayesian network in power systems.

Moreover, one of good neural networks which is not used yet in power systems is Fuzzy ARTmap which is a developed member of ART neural networks family.

This paper will focus on the construction and application of Bayesian network and Fuzzy ARTmap models. The Bayesian network (e.g., [2] and [3]) is a probabilistic graphical model in which a problem is structured as a set of variables (parameters) and probabilistic relationships among them. The constructed Bayesian network, after serial evidence–propagation inferences, sorts the transmission line faults according to their individual some more important harmonics occurrence probability. The major contributions of this paper are as follows.

In this paper, a Bayesian network and Markov chain Monte Carlo (MCMC) simulation technique is compared to Fuzzy ARTmap network in order to predict the faulted phase or phases in a typical high voltage transmission line.

The format of this paper is as follows. Section 2 and 3 present the fundamental of Bayesian and Fuzzy ARTmap networks, respectively. In Section 2, the proposed model structuring procedure and data assessment based on Radial Basis Function (RBF) method [4] will be presented. In the section 4, the transmission line's model and data required for Bayesian and FAM networks will be presented. The test results of constructed Bayesian and Fuzzy ARTmap network will be followed and concluding remarks will be given.