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Comparison of Bayesian and Fuzzy ARTmap Networks in Transformers PD Localization

Hamed Nafisi, Mehrdad Abedi, Gevorg B. Gharehpetian

Abstract – *Insulation system of high voltage equipment has a vital role in apparatus lifetime and continuity of power supply. In power transformers one major source which can cause insulation failure is partial discharge (PD). PD localization has significant importance in the maintenance and repair of a transformer. In this paper two methods by use of neural networks for identifying partial discharge locations in transformer winding are proposed. Detailed model (DM) of transformer is developed for simulation and detection of PD. With modeling of partial discharge impulse source in EMTP software, this phenomenon is implemented in different points of transformer winding. Then produced currents in the both ends of winding are used for training and test of neural networks. In actual, obtained current signals contain noisy components. Thus in this paper the performance of the Fuzzy ARTmap neural network and Bayesian network for correct determination of partial discharge location in power transformer with considering different noises on simulated current signals for simulation of actual conditions is surveyed.*

***Keywords**: Bayesian Network, Detailed Model (DM), Fuzzy ARTmap (FAM) Neural Network, Partial Discharge (PD), Power Transformer*

Nomenclature

R_{pi}	Dielectric losses between winding turns
R_{ei}	Dielectric losses between winding and tank (or other windings or core) respectively
R_{si}	Conductor resistance with skin and proximity effects
A	Inputs to ART_a
B	Inputs to ART_b
F_1^a	ART_a output vector
w_j^a	j^{th} ART_a weight vector
F_1^b	ART_b output vector
w_k^b	k^{th} ART_b weight vector
F^{ab}	Map field output vector
w_j^{ab}	Map field weight vector
ρ_a	ART_a vigilance parameter
ρ_{ab}	Map field vigilance parameter
$P(x_1,...,x_n)$	Generic entry in the joint
$q(x \rightarrow x')$	Probability that the process makes a transition from states x to state x'
$P_t(x)$	Probability of being in state x at time t
$P_{t+1}(x')$	Probability of being in state x' at time $t+1$
$\phi(x)$	Radial basis function
$y(x)$	Approximating function
ω_i	coefficient

I. Introduction

Partial discharges (PD) are well known as a source for insulation degradation and a major source of insulation failure in power transformers [1]. Power transformers play a major part in electricity transmission and distribution [2]. The capital cost of a transformer is extremely high and the economic penalties incurred by transformer failure, and the resulting outage costs, are considerable. If insulation deterioration caused by PD activity can be detected at an early stage, then incipient insulation faults can be identified and preventive maintenance measures taken [3]. Therefore, many researches in PD location detection are widely done and recently the quantity of performing researches in this area is considerable [4]. PD detection methods are classified into acoustical and electrical methods. Electrical methods are based on the taking created impulses in cavity of transformer insulation. Assessment of PD in electrical methods is possible by using current transducers which is connected to measurement terminals. In this method many different ways is used or now studying i.e., tip-up, dielectric loss analyzing, inductive probes, pulse detecting and analyzing, and etc [5]. In [6] acoustical method for PD localization is used.

The vantage point of the acoustical methods is the simplicity of locating algorithm but the sensitivity is not satisfactory. On the other side the complicated structure of power transformers is caused difficult finding PD with due attention to propagation velocity of acoustic waves

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