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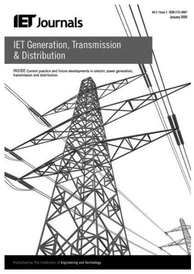

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Improvement in the performance of neural network-based power transmission line fault classifiers

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Abstract: A power line expert can easily pinpoint the type of fault that may have been occurred in a power transmission line. Transferring the experts intelligence to an artificial neural network (NN) makes the classification process fast and available online. Often the phase currents are used as NN inputs for this purpose. Lack of a somehow one-to-one relationship between the type of fault and the phases faulty currents prohibits the underlying network from being adequately trained. In a search for finding a type of feature that establishes a relatively unique link between the type of faults and the phase currents, it is noticed and mathematically proved that the ratios of the phase current jumps enjoy such a valuable advantage to be a prime choice as NN inputs. The inputs let a multi-layer perceptron (MLP) NN with about one node per phase to identify the faults accurately. The scheme works well in the presence of a various number of fault items. The superiority of the method is well realised when it is compared with the results of similar investigations using wavelet, fuzzy and others. The reference data are generated using MATLAB Power System Toolbox. The test samples are more general than those previously used in other investigations.

1 Introduction

In an electric power system comprising different complex interacting elements, there is always a possibility of disturbance and fault. Lightning, dirt/salt on insulators, line–line flashover because of wind, flashover to tree, tower/pole or conductor falls, objects fall on conductors are the source of faults which arc, fire, explosion and vibration are their consequences.

The transmission line faults are classified into balanced and unbalanced ones. The balanced faults are three phase (3L) and three-phase to ground (3LG) short circuits. Most of transmission line faults are of unbalanced nature. Single-line to ground (LG), line-to-line (2L) and double-line to ground (2LG) faults are categorised as unbalanced faults. High-impedance fault is often an unbalanced type.

Since it is important to protect the power system from unavoidable fault aftermath, power line experts are employed. They can easily identify the fault type; but, they are not adequately fast and may not be available online. Transferring the intelligence of the experts to an intelligent machine or an artificial neural network (NN) could provide excellent solution. Fault diagnosis involves three major tasks: detection, classification and locating. The automatic protection system must be (i) highly reliable and very sensitive to isolate targeted-fault (ii) adequately selective and (iii) fast.

Often the three-phase current amplitude jumps, because of a fault, are used for classification purpose and ground involvement is checked through the analysis of $i_z(n)$ (instantaneous zero current) and or a separate index derived from the phase currents. The signal feature used may be root-mean-square (rms) value [1], power of fundamental frequency (using discrete Fourier transform (DFT)), transient energy (calculated using wavelet [2] and or DFT) and even exact sample points [3, 4].

During years, different researchers have developed a number of fault classification techniques. Artificial NNs, as a powerful pattern recognition tool [5], could be applied to the line currents to firstly learn and secondly identify faulty phases quickly and automatically [6, 7]. Samantaray *et al.* [8] preprocesses the three phase currents using hyperbolic S transform and uses the difference between the pre- and post-fault energy for classification. The decision maker is a radial basis function (RBF)NN. Feeding an adaptive network and fuzzy inference (ANFIS) system by a set of $i_z(n)$ and the pre- and post-fault differences of the rms value of the three phase currents has been investigated by Yeoa *et al.* [1]. Mahanty and Gupta [3] employ the post-fault samples of the three phase currents, plus fuzzy strategy for fault identification. Mahanty and Gupta [4] also use samples of the three-phase currents and $i_z(n)$ as RBF inputs.

Multi-layer perceptron (MLP) [6, 7, 9, 10], RBF [4] and probabilistic NN [11] performance have been examined by researchers. Applications of wavelet [2, 12] and wavelet-NN [11, 13] have also been investigated. Study of fuzzy logic for fault distinction has been reported in [3, 12, 14]. Almost all the methods give acceptable success rate under