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Decision Tree based discrimination between inrush currents and internal faults in power transformer

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ABSTRACT

This paper presents a new approach for discriminating inrush currents from internal faults in case of power transformer protection using Decision Tree (DT). Differential current of one cycle inrush and internal faults are taken as inputs to the Decision Tree with corresponding target outputs as '0' for inrush and '1' for internal fault conditions. The DT is trained with inrush currents and internal faults with wide variations in operating parameters of the power network and provides accurate results in distinguishing inrush currents from internal faults. The proposed DT based algorithm is found to be accurate and robust, and thus highly suitable for power transformer protection.

1. Introduction

Power transformers play a vital role in any electric power system network. So it is very important to avoid any mal-operation and false tripping by providing required relaying system. Protection of large power transformers is a very challenging job in power system protection. The phenomenon of inrush current in the power transformers has been well known for many years and is an important aspect of harmonic restraint differential relay. The inrush current contains a large second harmonic component in comparison to an internal fault. Sometimes also, the second harmonic may be generated in case of internal faults in power transformer. This may be due to CT saturation and distributive capacitance in long transmission line to which the power transformer is connected.

In certain cases, the magnitude of second harmonic in an internal fault current can be close to or greater than that present in the magnetizing inrush current. Moreover, the second harmonic components in the magnetizing inrush current tend to relatively small in modern power transformer due to design improvements. Thus the commonly employed conventional differential protection based on second harmonic restraint will face difficulty in distinguishing inrush current and internal faults. Thus an improved technique is required to discriminate between inrush current and internal faults for providing effective power transformer protection.

Several methods for power transformer protection have been proposed using signal processing and artificial neural networks. The differential protection using Discreet Wavelet transform [1], based on energy distribution in time and frequency domain provides better results, which is not possible using Fourier transform. Another technique using wavelet transform [2], is based on the automatic signature recognition using wavelet coefficients for distinguishing inrush current from internal faults. Some other techniques [3–5] based on wavelet transform for transformer protection used the detailed and approximate coefficients in respective frequency band to distinguish between inrush current and faults in power transformer. To further enhance the performance, a wavelet packet based scheme for power transformer protection [6] has been proposed. Basically wavelet transform is a series of band pass filters which provides time–frequency information for band of frequencies. Consequently the wavelet decomposition coefficients in a frequency band reflect the overall effect of all signal components in the frequency bands, rather than the specific frequency components such as fundamental and harmonic ones. Also the frequency properties of the decomposition filter bands are not ideal and suffer leakage effects where the signal frequency is closer to the edge of a frequency band. The above works finds limitations as wavelet transform is highly prone to noise and provides erroneous results even with noise of SNR 30 dB [7].

Another improved technique has been proposed [8] using wavelet and neural network for distinguishing inrush currents and faults. In this technique features are derived using wavelet

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