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Review on Identification and classification of Faults in HVDC System using Wavelet Transform and Artificial Neural Network

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ABSTRACT: For HVDC transmission line protection Different methods like Distance Protection Method, Discrete Fourier Transform (DFT), Independent Component Method, Fuzzy Logic Method, Wavelet Transform (WT), Natural Frequency Method, Artificial Neural Network (ANN) etc are used. In the recent years different researchers are used different methods in this era and gets different result. This paper provides the theoretical overview on different methods used for HVDC transmission line protection.

KEYWORDS: HVDC, Discrete Fourier Transform (DFT), Wavelet Transform (WT), Frequency Method, Artificial Neural Network (ANN).

I. INTRODUCTION

In all over world for the long transmission of electricity high-voltage, direct current (HVDC) is the best option for it. It is also known as power superhighway or an electrical superhighway. It will provides different features like controllability of power flow, economy while transmitting bulk power over very long distances, lower transmission losses and absence of stability issues [1].

All these advantages make HVDC system more attractive than the high voltage Alternating current (HVAC) system. For safe and optimal operation of power Systems fast detection of fault in the fast acting HVDC systems in AC power systems. It is very important to detect accurate and rapid classification of fault to take the correct protective control decisions. By using pure frequency (not suitable for the time-varying transients) or pure time domain based methods (are very easily influenced by noise), it is very difficult to identify HVDC faults [2]. This paper will provides the literature survey on high voltage direct current (HVDC) transmission line protection with different methods developed in the recent years.

II. EXISTING SYSTEMS

In the recent years different researchers are used different methods in this era and gets different result. Following are the some methods which are used in the existing system. Ei Phy Thwe and Min Min Oo [3] present an application of artificial neural networks (ANNs) to the fault detection and classification in high voltage transmission lines. For detection and classification of the fault for analysis of each of the three phases, system uses Feed forward neural network along with back propagation algorithm. In this system ANN was trained and tested using various sets of field data received from the simulation of faults at various fault scenarios like fault types, fault locations and fault resistance.

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ANN method can efficiently be used for accurate fault classification on the transmission line. J Nandana et al [4] presents a most efficient method to reduce the harmonics contents in the HVDC transmission system. This system, the inverter topology gets improved through Selective Harmonic Elimination Technique. This system is basically based on the Selective harmonic eliminated pulse-width modulation technique (SHE PWM) technique. In the system fault data has been analyzed using back propagation algorithm and neural networks system is used to identify the type of the fault. ZhiGuo Zhou, QiYing Jin and Yi Zhang [5] present propose a set of AC inverter and DC line ports for the fault detection and the Mallat algorithm, which is used to detect the DC line fault as well as three-phase grounding fault in the flexible HVDC system. To distinguish the fault type Mallat decomposition is used with the high frequency wavelet coefficient amplitude. To determine the time and the time of the failure Mallat wavelet analysis is best and feasible tool. Rahil Abrol and Mr. Anshul Mahajan [6] presents wavelet based multi resolution analysis technique is used to extract the features of the signals with and without faults. This system considered a 12- pulse HVDC system in MATALB/Simulink environment. Fault cases like Normal operating case, Dc line fault and Ac fault (LG) at inverter end were simulated by the system.

Rommel Aguilar et al. [7] present presents an orthogonal decomposition Method is similar to a discrete Fourier transform. This method is used to extract information from the current transient signals generated after a fault. A set of EOFs are applied on fault data and are designed to extract relevant information from the first milliseconds of fault current signals. Directionality is highly related to the fault inception angle and this relation is used to determine the fault direction. This proposed method detects the fault direction without requiring the measurement of voltage transient. Yew Ming Yeap et al [8] present a Comparison between the two proposed methods named as capacitive discharge technique (CD method) and frequency-domain-based short-time Fourier transform (STFT) with the wavelet transform. The first technique capacitive discharge is nothing but the time domain analysis of the dc-link capacitor discharge and seconds the technique i.e. frequency-domain-based short-time Fourier transform is used for quantitative analysis of high-frequency components in the fault current. The CD method provides the fastest detection, followed by the STFT, and lastly WT. Zhixiong Li et al [9] proposed method lies that it appropriately introduced the ICA-wavelet to realize accurate fault feature extraction and the actual engineering data. Guangzhou HVDC system has been used to verify the effectiveness of the system. In this system, independent component analysis (ICA) feature extraction and a neural network fault classifier has been introduced by using Wavelet-based protection strategy. Liu Yue [10] present high voltage direct current (HVDC) transmission line ground fault location detection. The fault location method based on fast independent component analysis (Fast ICA) algorithm. In this proposed system the FastICA is used to isolate fault voltage traveling wave feature signals from multi-channel high voltage direct current transmission line voltage signals. First and second traveling wave head reach the measurement point are recognized, as well as the polarity of the two wave heads are distinguished.

III. PROPOSED SYSTEM

Proposed system based, shown in figure 1, on the measuring the DC line current signal, these signals is preprocessed to remove the noise and creates number of frames. The values of currents are measured and modified accordingly and are ultimately fed into the wavelet transform as inputs and decompose that current signal into approximation and detail coefficients. These calculated features can be given to the ANN as an input for the fault classification. Here wavelet can calculates the features by using db4 wavelet. Here four features can be calculated such as wavelet energy, entropy, variance and waveform length. Then these calculated features can be given to the ANN as a input for the fault classification. There are many types of ANNs but the most commonly used are the multi-layer feed-forward, a four-layer network (input, two hidden and output layers). Because of this, a fully connected three-layer feed-forward ANNs with Levenberg-Marquardt (LM) learning algorithm has been used in the complete fault classification.

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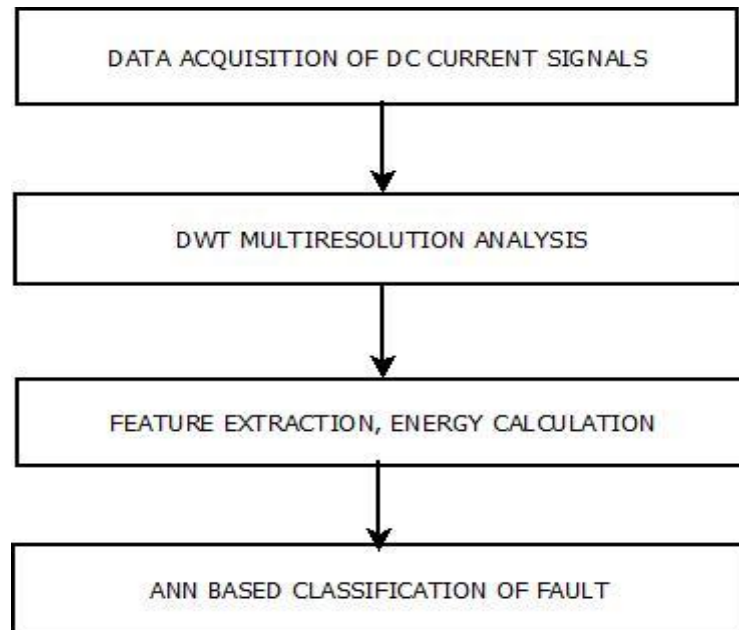


Figure 1 Process of fault Detection and Classification

Proposed system Analyze and Identification of HVDC system faults using Discrete Wavelet Transforms (DWT) and Artificial Neural Networks (ANN).

- **Discrete Wavelet Transforms (WT)**

Wavelet theory deals with building a model for non-stationary signals, using a set of components that look like small waves. DWT is easier than Continuous Wavelet Transform (CWT) and DWT uses filters of different cut-off frequencies to analyze the signal at different scales. When a signal passes through a series of high pass filters to analyze the high frequencies, and it is equally passed through a series of low pass filters to examine the low frequencies. WT of sampled waveforms can be obtained by implementing the discrete WT which is given by:

$$DWT(f, m, n) = \frac{1}{\sqrt{a_0^m}} \sum_k f(k) h^* \left(\frac{n - ka_0^m}{a_0^m} \right)$$

where, the parameters a_0^m and $k a_0^m$ are the scaling and translation constant respectively, k and m being integer variables and h is the wavelet function which may not be real, as assumed in the above equation for simplicity. In a standard discrete WT (DWT), the coefficients are sampled from the continuous WT on a dyadic grid $a_0=2$ yielding.

- **Artificial Neural Networks (ANN)**

Artificial Intelligence is a machine emulation of the human thinking process and two kinds of networks are commonly used as universal functional approximates, Radial Basis Function Network (RBFN) and Back-propagation feed-forward neural network (BPFN). RBFN consists of only three layers. The first layer is composed of input nodes whose number is equal to the dimension of the input vector. The second layer is a hidden layer, composed of non-linear radial basis neurons that are connected directly to all the nodes in the input layer. The output layer consists of single linear units, being fully connected to the hidden layer.

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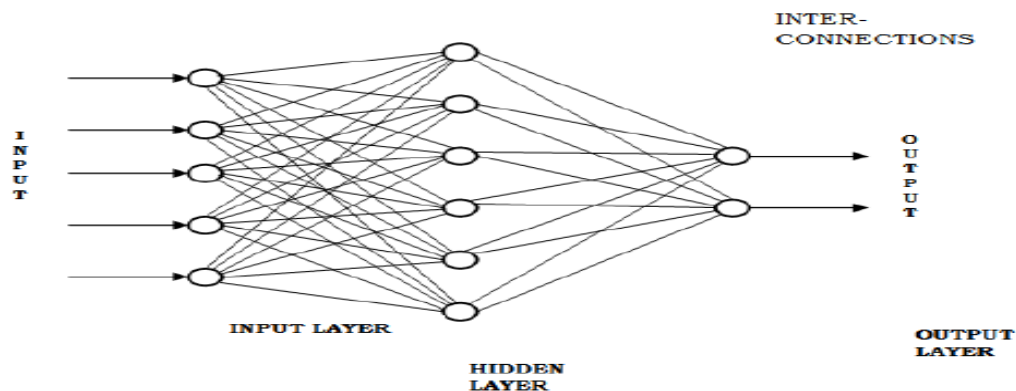


Figure 2 Architecture of a layered feed-forward neural network

IV. CONCLUSION

To recognize the accurate and reliable fault location in high voltage direct current (HVDC) transmission line is very essential for alternating current (AC) transmission. This paper provides the literature survey on different methods to detect the fault used in the recent years and provides proposed system also.

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