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A Survey: Fault Classification Techniques

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Abstract- Transmission lines consume a considerable amount of power. The necessity of power and its dependency has grown exponentially over the years. The void between limited production and tremendous demand has increased the focus on minimizing power losses. For a modern power system, high speed fault clearance is very critical and to achieve this objective various techniques have been developed. This paper presents survey of various techniques used for classification of transmission line faults.

Keywords – Transmission lines, faults, classification techniques, electric power system, fault detection.

I. INTRODUCTION

In power distribution system, transmission lines are the most imperative part, as they play a key role in the transmission of power from generating station to load centres. Transmission lines are used to transmit electric power to distant large load centres. The rapid growth of electric power systems over the past few decades has resulted in a large increase of the number of lines in operation and their total length. These lines are exposed to faults as a result of lightning, short circuits, faulty equipment's, miss-operation, human errors and overload. When faults occur in the power system, they usually provide significant changes in the system quantities like over-current, over or under voltage, power factor, impedance, frequency and power or current direction. Mostly 80-90% of the fault occurs on transmission line and rest on substation equipment's. The key challenge to the protection of transmission line lies in reliably detecting and isolating faults compromising the security of the power system.

The appropriate percentages of occurrence of various types of faults are given below:-

Single line to ground fault – 70-80%

- Line-to-Line to ground fault – 10 -17%
- Line-to- Line fault – 8-10%
- Three phase fault - 3 %

Rest of the paper is organised as follows, section I contains the introduction of transmission lines faults, Section II contains related work in which previous work done for classification of faults in transmission lines is discussed, Section III contains some of the most common techniques used for fault classification, Section IV contains conclusion, Section V contains references used.

II. RELATED WORK

[1] Author proposes fault detection and classification scheme for transmission line protection using wavelet transform and linear discriminant analysis (LDA).Current signals for each phase are used for the detection and identification of faulty phases and zero sequence currents are used for the detection of ground. All shunt faults and multi-location faults which occur in different locations at the same time are also detected and classified by the proposed scheme within one cycle time.

[2] Classification of power system faults using empirical mode decomposition (EMD) and support vector machine (SVM) is proposed. EMD is used for decomposing voltages of transmission line into intrinsic mode functions (IMF).Hilbert Huang Transform (HHT) is used for extracting characteristics feature from IMF.A multiple SVM model is introduced for classifying the fault condition among ten power system faults.

[3] Neural network approach to protection of transmission line is demonstrated in this paper. The suggested approach is based on the use of neuro-computing technology and implementation of pattern recognition concepts. This paper presents a positive approach to improve the performance of conventional algorithms.

[4] Wavelet Analysis and Singular Value Decomposition are well-known signal processing techniques for fault detection and identification. A new classification method for fault waveform is proposed based on discrete orthogonal wavelet transform (DOWT) and hybrid support vector machine (hybrid SVM) for fault type of a three phase voltage inverter. This paper describes a new approach with the combination of Wavelet Analysis and of Singular Value Decomposition for extraction of features from output voltage waveforms of the three-phase voltage source inverter, and the hybrid SVM to classify the faults.

[5] An accurate algorithm for fault location estimation and direction detection of phase-to-ground faults on single circuit transmission line fed from sources at both

ends is presented. The algorithm employs the fundamental components of three phase voltages and currents measured at one end only. The algorithm provides automatic determination of fault direction (forward or reverse) and fault location after one cycle from the inception of fault. The technique does not require communication link to retrieve the remote end data.

[6] In this paper, a new fault detection method is proposed for protection of transmission lines using RMS values of 3-phase instantaneous powers at both sending end and receiving end. The Input signal of any detection algorithm varies not only in case of faults but also other cases like High Impedance faults and different non fault situations like power swings, CT saturation and frequency deviations etc. A new fault detection method is presented in this paper by taking instantaneous power as input signal.

III. TECHNIQUES FOR CLASSIFICATION

There are various techniques which are used today for the classification of faults in the transmission lines. The brief description of these recently used techniques is as follows.

Artificial Neural Network

Artificial neural network is composed of number of inter-connected units (artificial neurons) and these networks are inspired by the learning processes that take place in biological systems. An artificial neural network is composed of many artificial neurons that are linked together according to specific network architecture. ANN has three layers i.e. input layer, hidden layer and output layer. ANN has primarily a high degree of robustness and ability to learn and have capability to work with incomplete and unforeseen input data. For protection of transmission line with ANN, it doesn't require any communication link to retrieve remote end data rather it takes data from local end only i.e. voltages and currents are taken from the bus bar.

Wavelet Techniques

Wavelet analysis is a relatively new signal processing tool and is applied recently by many researchers in power systems due to its strong capability of time and frequency domain analysis. The two areas with most applications are power quality analysis and power system protection. The definition of continuous wavelet transform (CWT) for a given signal x(t) with respect to a mother wavelet (t) is

$$CWT(a, b) = 1/(a)1/2 [x(t) ((t-b)/a) dt]$$

where a is the scale factor and b is the translation factor. Thus, the wavelet transform provides an efficient way to extract signal components at different frequency bands. Wavelet transformation is one of the most popular candidates of the time-frequency-transformations. In order to apply wavelet technique for protection purpose to some specific systems such as parallel lines, multi terminal lines, some adjustments are required.

Genetic Algorithms

A Genetic Algorithm (GA) is a search algorithm which is based on the mechanism of natural selection and natural genetics. The fundamental principle involved behind this is that the fittest member of a population has the highest probability for survival. There is a fitness value associated to each chromosome. The better the solution the chromosome represents, the larger its fitness and its chances to survive and produce offspring. In this context, the objective function establishes the basis of selection. The GA depends on two basic kinds of operators: genetic and evolutionary. Genetic operators, namely crossover and mutation, are responsible for establishing how individuals exchange or simply change their genetic features in order to produce new individuals. Evolutionary operators deal with determining which individuals will experience crossover or mutation.

Support Vector Machine

SVM has the edge of good generalization over other fault diagnosing applications because it is based on pattern recognize algorithms. SVM is a classifier that has a high learning capacity proved to be efficient in many applications. The learning capacity can be judged from its ability to model complex and real world issues that may include image and text classification, bioinformatics, hand-writing recognition and analysis of bio-sequence. SVM possesses the capacity to perform explicitly well on sets of data having many attributes, even there is a shortage of cases for the training of the model. SVM has faster and more accurate computational ability than traditional techniques, because of the inherent property of SVM as it requires less training data than other methods.

ANIFS Technique

Adaptive neuro-fuzzy inference system (ANIFS) is the advanced application of artificial intelligence which was introduced recently for protection of transmission line. ANIFS can be viewed as fuzzy system, neural network or fuzzy-neural network. A fuzzy neural network or neuro-fuzzy system is a learning machine that finds the parameters of a fuzzy system (i.e., fuzzy sets, fuzzy rules) by exploiting approximation techniques from neural networks. This technique is divided into three different tasks of fault detection, classification and isolation. With this technique, less operating time and reduced mean-squared error can be achieved.

IV. CONCLUSION

For classification of faults in the transmission lines various techniques are used. Some of the most common techniques which are used world-wide are presented in this paper. This paper represented a review of most common techniques for the classification of faults in the transmission lines. The combination of two or three

techniques can also be used for classification of faults with high accuracy.

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