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A Review on Transmission Line Faults Detection

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Abstract –**Power transmission and distribution lines plays vital roles in Power System it has to achieve the essential continuity of service of electrical power to the end users. Transmission lines connect the generating stations and load centers. As the generating stations are far away from the load centers they run over hundreds of kilometers. Hence, the probability of fault occurrences in transmission lines is very high. Since faults can destabilize the power system it must be isolated immediately for restoration of power supply. Fault analysis is very important issue in power system engineering in order that to clear faults quickly and restore power supply as soon as possible with minimum interruption. This paper presents a literature review of transmission line faults detection.**

Keywords – **DWT, Neural Networks, Transmission Line.**

I. INTRODUCTION

Transmission lines are devices that were designed for the propagation of electricity from one point to another. These lines are used to transfer the RF energy output of a transmitter to an antenna. The energy could not travel through the normal electrical lines efficiently (without considerable losses). Though the antenna can be directly aligned with the transmitter, yet it is placed some block away from the transmitter. On board ship, the transmitter is placed in a radio room and the antenna is installed on a mast. Both the devices are connected via a transmission line.

The primary purpose of the transmission line is same for both the transmitter and the antenna. The purpose is to carry the output energy of the transmitter to the antenna with minimal power dissipation. The scalability of the transmission lines relies highly on the special electrical (resistance and impedance) and physical characteristics of the transmission lines.

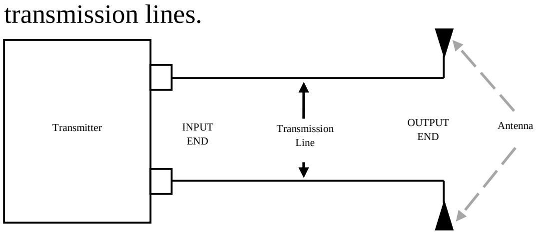

Figure 1: Simple transmission line

The transmission line has two finite ends. The one of this line goes into a socket of the source that is commonly termed as the Input End or the Generator End. These are also called as the Transmitter End, Sending End or the Source. The other end of the transmission line is connected to the antenna and is referred as the Output End or the Receiving End. Also it is called as the Load End or the Sink.

II. CLASSIFICATION OF TRANSMISSION LINES

The transmission line can be studied with the three constants; R (Resistance), L (Inductance) and C (Capacitance). These factors are distributed in a line uniformly across whole length. The inductance and the resistance are the two factors that form series impedance. The capacitance that exist between the conductors for a single phase line or from the conductor to neutral for the three phase line forms a shunt path across the length of the line. Therefore the effects of capacitance introduce complications in the transmission line calculations. Overhead lines are classified on the basis of the presence of capacitance in a line.

Short Transmission Lines

The overhead transmission lines up to the range of approximately fifty kilo-meters and the voltage of line under (<20kV) are considered to be a part of the short transmission line. Due to the low voltage and smaller length, the capacitance effects are minute enough not to trouble the transmission hence they are neglected. Therefore only the resistance and inductance of the line is taken into account.

Medium Transmission Lines

The transmission lines of the range lying between the fifty to one hundred and fifty kilometres carrying the voltage of the range $20 < V < 100$ kV are considered as the medium transmission range. Due to this length and voltage, the capacitance effects show a severe effect in the line and are thus needed to be considered. For the calculation purpose, the distributed capacitance in the line is distributed and lumped in the condenser form that are shunted at one or more points across the line.

Long Transmission Lines

For the overhead transmission lines of the range more than 150 km along with the line voltage ranging more than 100 kV, the term long transmission line is used. To deal on such a large scale the line constraints are divided uniformly over

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the whole length and rigorous methods are employed for solution purpose.
Also we can say that the exact solution for the long range transmission lines consider the fact that line constants are not lumped and are distributed throughout the length of line in a uniform manner. However, by considering these constants as lumped for medium and short range transmission lines the reasonable accuracy can be obtained.

III. Losses in Transmission lines

Power generated in power stations pass through large and complex networks like overhead lines, transformers, cables and other equipment and reaches at the end users. It is fact that the single unit of electric energy generated by Power Station does not match with the units distributed to the consumers. However, some percentage of the units is lost in the distribution network.

$$Transmission\ and\ Distribution\ Losses = \frac{(Energy\ Input\ to\ Feeder\ (Kwh) - Billed\ Energy\ to\ consumer\ (Kwh)}{Energy\ Input\ Kwh} \times 100 \quad (1)$$

Some of the major transmission losses are mentioned here. There are two types of technical losses; Fixed and Variable.

Fixed Losses

- Fixed losses do not vary according to current. These losses take the form of heat and noise and occur as long as a transformer is energized
- Between 1/4 and 1/3 of technical losses on distribution networks are fixed losses. Fixed losses on a network can be influenced in the ways set out below
- Corona Losses
- Leakage Current Losses
- Dielectric Losses
- Open-circuit Losses
- Losses caused by continuous load of measuring elements
- Losses caused by continuous load of control elements

Variable Losses

These vary with the amount of electricity distributed in the line and are, proportional to the square of the current. Consequently, a 1% increase in current leads to an increase in losses of more than 1%.

- Between 2/3 and 3/4 of technical (or physical) losses on distribution networks are variable Losses.
- By increasing the cross sectional area of lines and cables for a given load, losses will fall. This results in direct trade-off between cost of losses and cost of capital expenditure. Some researchers have suggested that optimal average utilization rate on a distribution network that considers the cost of losses in its design could be as low as 30 per cent.
- Joule losses in lines at each voltage level
- Impedance losses
- Losses caused by contact resistance.

Main Reason for Technical Losses

1. ***Lengthy Distribution Lines:*** This results in high line resistance and therefore high I^2R losses in the line.
2. ***Inadequate Size of Conductors of Distribution Lines:*** The size of conductors should be adequate but are generally varied in rural areas.
3. ***Installation of Distribution transformers away from load centers*****:** This again leads to higher line losses.
4. ***Low Power Factor of Primary and secondary distribution system:*** A low Power Factor contributes towards high distribution losses.
5. **Feeder Phase Current and Load Balancing:** One of the easiest loss savings of the distribution system is balancing current along three-phase circuits.
6. Load Factor Effect on Losses.
7. Transformer Sizing and Selection
8. Balancing 3 phase loads
9. Switching off transformers
10. Other Reasons for Technical Losses
    - Unequal load distribution among three phases in L.T system causing high neutral currents.
    - Leaking and loss of power
    - Over loading of lines.
    - Abnormal operating conditions at which power and distribution transformers are operated.
    - Low voltages at consumer terminals causing higher drawl of currents by inductive loads.
    - Poor quality of equipment used in agricultural pumping in rural areas, cooler air-conditioners and industrial loads in urban areas.

IV. Literature Review

Crowther et al. (1998) presented fault diagnosis of a hydraulic actuator circuit using neural networks an output vector space classification approach motivated to use neural network for faults identification [1].

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Tahar Bouthiba (2004) presented a paper which deals with the application of artificial neural networks to fault detection and location in extra high voltage transmission lines for high speed protection using terminal line data. The proposed neural fault detector and locator were trained using various sets of data available from a selected power network model and simulating different fault scenarios fault resistances and different power system data. Three fault locators are proposed and a comparative study of the proposed fault locators is carried out in order to determine which artificial neural network fault locator structure leads to the best performance [2].

Signal processing is one of the most important parts of the digital distance protection schemes in order to clear faults quickly and restore power supply as soon as possible with minimum interruption. The faulted phase's identification is done by analyzing the detail coefficients of the phase currents. To distinguish ground faults from phase to phase ones, the analysis of the smooth coefficients of the neutral current can be used. **Reddy et al. (2005)** proposed a model based upon a combination of the impedance calculation and the Continuous Wavelet Transformation method to detect the disturbance along with distance of Fault occurrence. MATLAB/Simulink is used to generate fault signals and verify the correctness of the algorithm. Simulation results reveal that the performance of the proposed fault detection indicator is promising [3].

Karthikeyan Kasinathan (2007) presented a thesis which aims at detecting and classifying the power system transmission line faults. To deal with the problem of an extremely large data set with different fault situations, a three step optimized Neural Network approach has been proposed. The approach utilizes Discrete Wavelet Transform for detection and two different types of self-organized, unsupervised Adaptive Resonance Theory Neural Networks for classification [4].

Shaaban et al. (2010) proposed a power system fault identification scheme using information conveyed by the wavelet analysis of power system transients for detecting types of transmission line faults. The work presented in this paper is focused on identification of simple power system faults. Discrete Wavelet Transform (DWT) analysis of the transient disturbance caused as a result of occurrence faults is performed. The maximum detail coefficient, energy of the signal and the ratio of energy change of each type of simple simulated fault are characteristic in nature and used for distinguishing fault types [5].

Suhaas Bhargava Ayyagari (2011) presented a thesis based on detecting, classifying and locating faults on electric power transmission lines. Fault detection, fault classification and fault location have been achieved by using artificial neural networks. Feedforward networks have been employed along with back propagation algorithm for each of the three phases in the Fault location process. Analysis on neural networks with varying number of hidden layers and neurons per hidden layer has been provided to validate the choice of the neural networks in each step. Simulation results have been provided to demonstrate that artificial neural network based methods are efficient in locating faults on transmission lines and achieve satisfactory performances [6].

Tayeb et al. (2011) presented the use of back-propagation (BP) neural network architecture as an alternative method for fault detection, classification and isolation in a transmission line system. The main goal is the implementation of complete scheme for distance protection of a transmission line system. In order to perform this, the distance protection task is subdivided into different neural networks for fault detection, fault identification (classification) as well as fault location in different zones [7].

Dutta et al. (2011) presented intelligent control for locating fault in transmission lines by using neural network adapted MATLAB software for designing desired output [8].

The ability to learn, generalize and parallel processing, pattern classifiers is powerful applications of Artificial Neural Network used as an intelligent means for detection therefore **Eisa Bashier M Tayeb (2013)** adapted neural network architecture for fault detection in a transmission line power system. This paper aims to implement complete scheme for distance protection that subdivided into different neural networks zones. Single phase to ground, double phase and double phase to ground faults are considered. As a result a protection relaying system for the power transmission line systems can be done using the neural network back propagation architecture [9].

Soft Computing methods is considered an important extension to the quantitative model-based approach for residual generation in fault diagnosis. When quantitative models are not readily available, a correctly trained neural network can be used as a non-linear dynamic model of the system. However, the neural network does not easily provide insight into model. This main difficulty can be overcome using qualitative modeling or rule-based inference methods. **Srivastava et al. (2014)** presented the properties of several methods of combining quantitative and qualitative system information and

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their practical value for fault diagnosis of neural network [10].

Kesharwani et al. (2014) proposed a model based on MATLAB software to detect the fault on transmission line has been proposed. The output of the system is used to train an artificial neural network to detect the transmission line faults. Fault detection has been achieved by using artificial neural network [11].

Desai (2014) shows right different scheme for detection and classification of faults on transmission line. The scheme is to use neural network and wavelet transform together, to choose a proper way for solving the problem. Wavelet transform has strong mathematical, very fast and accurate tools for transient signal in the transmission lines which was used in artificial neural network that can make a different between measured signal and associated signal that has different pattern. It can be done by using specific algorithm [12].

V. Conclusion

Carrying out literature review is very significant in any research project as it clearly establishes the need of the work and the background development. It generates related queries regarding improvements in the study already done and allows unsolved problems to emerge and thus clearly define all boundaries regarding the development of the research project. This paper reviews about recent papers of transmission line fault detection and classification.

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